

The information provided in this report is largely the result of a two-day symposium on Alaska's Oceans and Watersheds, held in Anchorage, Alaska on June 18 and 19, 2002. The symposium consisted of five invited talks and seven panel presentations covering issues such as the effect of climate on ocean carrying capacity; status and trends in Alaska's marine fish, shellfish, birds, and mammals; persistent pollutants in Alaska's environment; and how changes in technology and management can help ensure sustainable resource use.

The symposium was sponsored by the following organizations:

State of Alaska

University of Alaska

Exxon Valdez Oil Spill Trustee Council

North Pacific Research Board

North Pacific Fisheries Management Council

Alaska Coastal Policy Council

Alaska Board of Fisheries

U.S. Geological Survey

U.S. Fish and Wildlife Service

U.S. Environmental Protection Agency

National Oceanic and Atmospheric Administration

The views in this publication are those of the authors and presenters and do not necessarily represent the views of the sponsoring organizations.



The Status of
Alaska's Oceans & Watersheds
2002



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Introduction

"To the lover of pure wildness Alaska is one of the most wonderful countries in the world Never before this had I been embosomed in scenery so hopelessly beyond description In these coast landscapes there is such indefinite, on-leading expansiveness, such a multitude of features without apparent redundance, their lines graduating delicately into one another in endless succession, while the whole is so fine, so tender, so ethereal, that all pen-work seems hopelessly unavailing. Tracing shining ways through fiord and sound, past forests and waterfalls, islands and mountains and far azure headlands, it seems as if surely we must at length reach the very paradise of the poets, the abode of the blessed."

- JOHN MUIR, Travels in Alaska, 1915 -

Ithough Alaska has gone through many changes since John Muir first visited in 1879, it remains a land of vast and varied landscapes: from temperate rainforests and alpine mountaintops in the southeast, to interior boreal forests and taiga, and north to the North Slope coastal plain. Stretching 2,700 miles from east to west and 1,700 miles from north to south, Alaska has a land area of 586,412 square miles, making it the largest state in the nation and the only arctic ecosystem within the borders of the United States. It has about 55 million acres of inland waters and its boundaries are defined in large part by 47,000 miles of coastline. These oceans and watersheds are home to rich terrestrial and aquatic life, providing commercial, recreational and subsistence resources to many of Alaska's people.

The marine ecosystems surrounding Alaska are incredibly vast, complex and dynamic. Winds, waves and tides shape Alaska's coast and weather patterns and play a strong role in determining the distribution and abundance of marine resources. Tiny plants and animals called plankton form the base of a vast food web supporting most seabirds, marine mammals and fishes and making the cold and

turbulent waters of the Gulf of Alaska and the Bering Sea among the world's most productive ocean regions.

The intertidal and shallow subtidal habitats in Alaska represent a variety of near-shore estuarine, fjord and exposed coastal settings. These habitats range from precipitous and rocky to gently sloping with muddy or sandy bottoms. Here microalgae, seaweeds and seagrasses support many invertebrates that, in turn, are food for fish, marine birds and mammals. These inhabitants include 100 million seabirds representing 66 species, 32 species of marine animals and huge marine fish stocks.

Extensive coastal watersheds provide spawning and rearing habitat for anadromous species such as Pacific salmon and eulachon, and nesting habitat for some seabirds like marbled murrelets. These areas also provide food for terrestrial species including bear, deer, moose, otter, and beaver. The carcasses of spawned-out salmon supply substantial amounts of marine-derived nutrients to the poorly nourished streams, lakes, and rivers used for their reproduction. In addition, dying salmon provide a food supply for many birds and mammals throughout the coastal range.

Bears, eagles and gulls are among those that benefit locally from this extensive forage resource. Alaska's diverse and abundant wetlands provide nesting habitat for 37 species of ducks, geese and swans with populations totaling more than 10 million.

The people of Alaska rely heavily on their oceans and watersheds. Anthropologists believe that Alaska's Native people originated in Asia, either crossing to Alaska over the Bering land bridge from Siberia or traveling by watercraft along the shorelines. While it is clear from archeological and Native history that people have lived in parts of Alaska for at least 10,000 years, there also is some evidence that colonization may have taken place thousands of years earlier. Many of Alaska's Native people today continue to follow the traditions of their ancestry by obtaining their livelihoods from the sea, and many Native communities still rely heavily on both terrestrial and aquatic resources for subsistence foods. The central role of marine fish and wildlife resources in the Native subsistence economies profoundly influenced the social organization of pre-contact societies and shaped their spiritual and cultural values. These resources play equally important economic and spiritual roles today.

Since the "discovery" of Alaska and through the period of colonization and then statehood, exploitation of natural resources has been the mainstay of the economy. Fishing, whaling, logging, mining, and other natural resource-based industries supported the early settlers and helped Alaska grow. The development of oil and gas greatly accelerated that growth. Even so, although oil revenues make up approximately 85 percent of the state government's budget, tourism, commercial fishing, logging, and mining are still vital components of Alaska's economy.

Alaska's environment is among the most pristine in the world, yet it is not immune to changes taking place both nationally and globally. The actual and potential impacts of natural or human-caused change, whether it is climate change, habitat loss or degradation, pollution, or unsustainable extraction of resource, are real. They signal a warning that Alaskans need to be proactive about understanding the causes of these changes and prepare to respond as needed to maintain a healthy ocean and coastal ecosystem.

Some of these changes are subtle and long term; others are startling and demand immediate attention. Steller sea lions have experienced a population decline of more than 80 percent in the eastern Bering Sea and western Gulf of Alaska. The fur seal population in the Bering Sea has declined by half since 1950, and in some regions, populations of seabirds such as thick-billed murres and red-legged and black-legged kittiwakes have also declined by 50 percent. The sea otter population in the Aleutian Islands has dropped by more than half in just the past five years. Some western Alaska salmon runs have experienced dramatic declines, even though most parts of Alaska have been blessed with healthy runs.

This report presents information gathered during the first *Alaska Oceans and Watersbeds Symposium*, which brought together a variety of researchers, policy makers and community members to discuss the state of Alaska's oceans and watersheds. This two-day symposium, held on June 18-19, 2002 in Anchorage, Alaska, was the first attempt to feature in one place a discussion of the myriad ocean and watershed issues facing the state. The symposium included talks on topics ranging from the causes of variability in fish, bird and mammal populations, to recent concerns over the detection of contaminants in the Alaska arctic. Panel presentations addressed these and other issues from a variety of perspectives including academia, government, Alaska Natives, and industry.

Included in this report are papers based on the invited talks and summaries of the panel presentations. Both papers and panel summaries have been peer-reviewed, but it should be noted that the views expressed by the authors are not necessarily those of the symposium sponsors.

The very size of the topic area, and of Alaska itself, precludes comprehensive coverage of all ocean and watershed issues in the state in this single report. It is hoped, however, that this symposium made a start at identifying issues of concern where action is needed. Immediately following this introduction, we provide a *Status of Alaska's Oceans and Watersheds* summary based on the information in the report, as the beginning of what we hope will prove to be a helpful tool for resource managers, stakeholders and residents to use in managing, conserving and protecting Alaska's spectacular marine resources.

Report Card

The Status of Alaska's Oceans & Watersheds 2002









Alaska's size, sparse population, and general remoteness help ensure that most watersheds are relatively pristine. Localized water pollution is a concern in urban areas and near mining operations, seafood processing facilities, and forest products facilities.

Fisheries





of concern

Salmon: Total commercial harvest of Alaska salmon appears to be in decline since 1995. Competition with farmed salmon has significantly decreased the value of commercial salmon harvests.

ood boo

 $\textbf{Groundfish:} \ \ \text{Harvests have remained relatively high; however, localized declines have been detected.}$

of concern

Crab: Commercial landings of king crab have decreased significantly, especially in the Gulf of Alaska. Tanner and snow crab landings have been mixed, but are currently at low levels.

of concern

Shrimp: Commercial harvest of shrimp in the Gulf of Alaska and Bering Sea declined precipitously after 1988. Small amounts are still harvested in Southeast Alaska.

Traditional Foods





Alaska's traditional foods are healthful and beneficial. There is some concern about potential contaminants in traditional foods, but this concern is not sufficient to discourage use of these foods.

Fish & Shellfish





Salmon: Several salmon populations in the Gulf of Alaska appear to be declining, while populations in Southeast Alaska are stable or increasing.



Pollock: Most pollock populations are stable, with some declines being noted in the Gulf of Alaska.

of concern

Herring: Recently herring roe fisheries have been closed in some parts of SE Alaska, Prince William Sound and Cook Inlet as a result of low spawning populations. In Prince William Sound, the herring population continues to be at very low levels despite closures of the herring fisheries.



Halibut: Halibut stocks are believed to be in generally good condition.

Groundfish: Bering Sea and Aleutian groundfish stocks are believed to be in good condition, while those in the Gulf of Alaska are considered stable.



Crab: King crab populations in the Gulf of Alaska and Bering Sea have declined, while snow and tanner crab populations are fluctuating between high and low levels.



Shrimp: Shrimp populations have declined throughout the state.

Marine Mammals



of concern



Sea lions: The western Pacific population of Steller sea lions is in serious decline, while the eastern population appears to be stable.





Seals: Northern fur seal populations are considered depleted under the Marine Mammal Protection Act.

good

of concern

mixed



Killer whales: The population of one resident pod of killer whales in Prince William Sound decreased after the 1989 Exxon Valdez oil spill and has still not reach pre-spill numbers. Data on other pods, especially non-resident pods, are too sparse to identify specific population trends.

of concern



Beluga whales: Cook Inlet beluga whales decreased between 1994 and 1998, when new subsistence hunting regulations were implemented. Since 1999 subsistence harvest has been reduced; however, it is too early to tell whether population declines have been halted.

mixed



Sea otters: Sea otter populations in the Aleutian Islands have decreased significantly, while elsewhere in the state, populations are stable or increasing.

good

Seabirds, Sea Ducks and Sea Geese





of concern



of concern



decline on St. George Island has decreased in recent years.

of concern



Kittlitz's murrelets: The Glacier Bay population, one of the largest, has declined by 80% in the past decade.



Spectacled and Steller's eiders: Spectacled eider populations have been steadily declining since the 1960s. Steller's eiders, once abundant on the Yukon-Kuskokwim Delta, have essentially disappeared.

of concern



Emperor geese: Abundance fell significantly in the 1960s, but appears to be increasing.



The State of Alaska's Approach to Oceans and Watersheds Management

The first photographs from space showed the earth as a planet of great oceans. Now, earth is known as the blue planet because three-quarters of its surface is covered by oceans. Yet, some of the blue may be turning brown as life is choked out of the world's waters. We must turn the tide. In Alaska, our environment, culture and economy are inextricably linked to the health of our oceans and watersheds.

No state is more blessed by, no state is more dependent upon, no state has more responsibility for and no state has more opportunity to benefit from the abundance of healthy oceans than Alaska. Our state's oceans are significant internationally; our rivers and watersheds are among the mightiest and most productive anywhere.

We are not immune from changes taking place nearby our home or on distant shores and our oceans are dependent on a change of attitude. Ecosystem-based management is the only rational way to bring science to bear on all of the interrelated issues. As our understanding of new science and management increases, we have changed our approach in recent years:

- The North Pacific Anadromous Fish Commission has worked on strategies for high seas fish research and policy.
- The Sitka Salmon Summit and recently negotiated Yukon River and Pacific salmon treaties recognize habitat, sustainable harvesting and the need for research.
- The state's Salmon Management Program was certified by the Marine Stewardship Council as sustainable, making it the first major fishery in the world to attain that status.
- Operation Renew Hope responded to disastrously low salmon returns by addressing the immediate needs of western Alaska families, fishermen and communities.
- With the Bering Sea Task Force, we saw how Alaska must act to provide a better understanding of marine ecosystems and a greater capacity to sustain healthy fish and wildlife populations through comprehensive and coordinated research.
- Alaska Clean Water Actions, in an inter-agency team effort, has made progress in keeping Alaska's waters clean.

(opposite page)
Visualization of planet earth
centered on the North Pole.
Photo courtesy NASA.

(right) Orca. EVOS photo library, Craig Matkin.



- Fish habitat measures have been established by the North Pacific Fisheries Management Council, Alaska Department of Fish and Game and the Board of Fish.
- Ecosystem-based recovery measures regarding declines in marine mammal species such as sea lions and Aleutian sea otters are progressing.
- Alaskans helped negotiate an *International Persistent Organic Pollutants Treaty* last year and legislation implementing the *National Persistent Organic Pollutants Treaty* is pending. Alaskans need to know our wild food will always be safe to eat, which means that the production and the distribution of persistent organic pollutants must be curtailed.
- The Wild and Traditional Foods Safety Initiative brought Native tribal leaders together with scientists and health experts, calling for a long term commitment to monitoring our wild foods.
- The Department of Environmental Conservation's Fish Testing Program will help ensure that Alaska's wild, naturally organic seafood remains so.
- Alaska pushed for Cruise ship standards to strengthen federal laws and standards for cruise ship gray water and sewage discharges, keeping Alaska's waters pristine.

Much has already been accomplished to protect the health of our oceans, which serves as an inspiration to accomplish what's next in line. With regard to sustaining Alaska's wild salmon heritage, we're working hard on the next steps of ensuring adequate in-stream flow, stronger

habitat protection along interior streams, and providing safe passage or—as stated eloquently by Northwest tribal fishermen—gravel-to-gravel protection, for salmon throughout their life history.

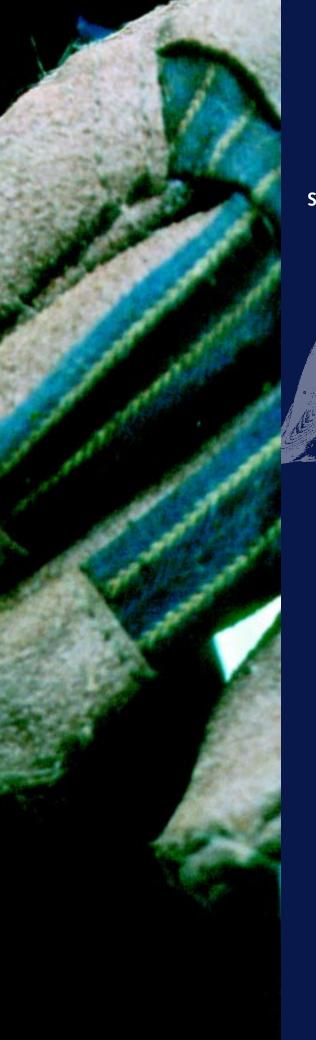
Our goal is to sustain the productivity and richness of our oceans and watersheds, a goal shared by the Pew Oceans Commission, on which I'm honored to serve as chair of the governance committee. An independent group of scientists, business leaders, fishermen and elected officials, the Oceans Commission is tackling some of the thorniest issues facing America's oceans: pollution, coastal development, impacts of fishing and governance of ocean resources.

We must have a unified regional and national response that recognizes the critical importance of the next frontier of our oceans and watersheds. The time has come for a national ocean policies act—a sound policy to protect, sustain and restore the ocean's living resources, backed by a sustained and coordinated commitment to research.

We need grassroots support that brings a sense of urgency for action on these issues. So please join me in recommitting ourselves and our resources to better protect our oceans. Let's do everything we can to make sure the blue planet stays blue and that the next frontier remains a place of great beauty and great abundance.

These remarks were given as a keynote address by Tony Knowles, Governor of the State of Alaska from 1994-2002, at the Oceans and Watersheds Symposium in Anchorage, Alaska, June 18, 2002.





Section I: Panel Presentations

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1. Variability in Alaska's Salmon Stocks

Panel Moderator:

Phillip R. Mundy, Science Director, GEM/Exxon Valdez Oil Spill Trustee Council

Population Levels are Fixed by Events During a Critical Period: Critical Size Hypothesis.

Pichand Population Fishering and Occupation of Control Program of Control

Richard Beamish, Fisheries and Oceans Canada

Is the North Pacific Ocean's Carrying Capacity for Pacific Salmon Limited?

Douglas M. Eggers, Alaska Department of Fish and Game

Ocean Carrying Capacity Program.

John H. Helle, Auke Bay Laboratory, National Marine Fisheries Service

Natural and Human-induced Limitations to Salmon Sustainability:
Adjusting Expectations.

Eric Knudsen, Alaska Science Center, U.S. Geological Survey

The following is a synopsis of the above presentations and does not necessarily represent the views of individual panelists.



1. Variability in Alaska's Salmon Stocks



To manage salmon for continued, sustainable human use, managers must understand how natural cycles and human activities affect fluctuations in salmon abundance.

Salmon have long been an important resource in Alaska, providing economic, recreational and cultural sustenance. All five species of Pacific salmon (pink, sockeye, chum, coho, and Chinook) are present in Alaska. Overall state-wide commercial salmon harvests have been at or near historic highs over the last two decades, although sockeye, Chinook and coho harvests have fluctuated downward since 1995. Geographic variation in harvest within species can be substantial, with western Alaska chum harvests approaching historic lows during the same two decades as the state as a whole experienced historic high chum salmon catches. In addition, the overall economic value of the harvests in recent years has declined significantly due to a number of complex worldwide factors, including increases in the production of farmed salmon. To manage salmon for continued, sustainable human use, managers must understand how natural cycles and human activities affect fluctuations in salmon abundance.

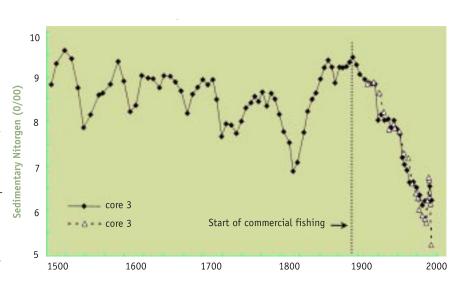
Natural Regulation of Salmon

As anadromous fish, salmon spend a portion of their life at sea and return to freshwater streams, rivers and lakes to spawn and die. As a result, variables in both freshwater and marine systems naturally regulate salmon abundance over the short and long term. It has been established within the last two decades that large scale, long term swings in salmon abundance and catches have occurred throughout Alaska's history. These long term swings have been associated with large scale environmental changes, such as increased or decreased ocean temperatures and major shifts in species biomass, that result from natural, and possibly human-induced (e.g., past high seas fishing), events. One way salmon cope with this extreme environmental variability is to evolve a large number of different stocks for each species. Large numbers of stocks maximize the opportunities for a species to survive and reproduce because stocks differ in how they respond to environmental fluctuations, and straying from abundant stocks helps to revitalize diminished populations. Stocks show heritable differences in traits such as time of spawning and ocean migration. These stockspecific traits determine how stocks interact with both short and long term environmental fluctuations. Recent research demonstrates that the geographic extent of individual salmon stocks can be very limited, with stocks demonstrating identifiably unique traits at the level of small streams.

The salmon life cycle begins when salmon eggs are deposited in the bed of a river, lake or stream. Young of all pink and chum salmon stocks move to saltwater soon after they are hatched. The young of all coho, most Chinook and nearly all sockeye salmon stocks on

the other hand, remain in freshwater for one to three years before heading out to sea.

The amount of nutrients in freshwater systems may naturally regulate salmon abundance. Recent research suggests that knowing the number of salmon that are allowed to escape, spawn and then die in freshwater may be essential in determining the number of salmon that a given water body can produce. Nutrients from decomposing salmon may play a critical role in determining the carrying capacity of freshwater systems for salmon production. One study on the Karluk Lake system



(figure 1.1) on Kodiak Island has used stable isotopes of nitrogen in sediment core samples from the lake as a surrogate for sockeye salmon escapement. The results of this study suggest that the total return of sockeye salmon biomass to the Karluk Lake system fluctuated widely for hundreds of years, but declined dramatically with the advent of commercial fishing, which decreased the number of salmon that were allowed to spawn and die in the lake. This decrease may have reduced the amount of nutrients available to support food production for juvenile salmon in the early stages of their life, which thereby reduced the ability of the Karluk Lake system to produce sockeye salmon.

Of those salmon that eventually enter the ocean, about 90 to 98 percent may die before they can return to their natural streams to spawn. Thus, even a small change in ocean survivability can make a large difference in the number of salmon that return to spawn. The first marine year is one of the most critical periods for determining ocean survivability. During this year, salmon entering the ocean encounter a period of predationbased mortality that is most severe for the smaller sizes of young salmon. To avoid predation and survive, salmon must grow to reach a critical size beyond which the mortality due to predation is thought to be diminished. Growth-based mortality occurs when juvenile salmon are unable to obtain sufficient food and grow to a large enough size to be able to survive the winter. Growth-based mortality is present in all ecosystems, but in some systems, it may play a more important role in determining the number of salmon that will survive to reach adulthood.

Research conducted in Canada's Gulf of Georgia suggests that this ecosystem may be food-limited, such that the overwinter mortality is as high as 80 to 95 percent of the total volume of coho salmon entering the strait. Additional data from scale analysis shows that fish that grew faster during the first summer in the marine environment were also the fish that had the best chance of surviving the first winter. In a system such as this, where salmon abundance is naturally regulated by the abundance of food and the ability of juvenile salmon to reach a critical size, salmon survivability is highly density-dependent.

figure 1.1 Nitrogen Content of Karluk Lake

Sedimentary marine-derived nutrients as a surrogate for historic, pre-harvest escapement in Karluk Lake. While populations appear to have fluctuated naturally, the total delivery of biological inputs to the freshwater system appears to have been reduced once fishing began.

Credit: Schmidt et al. 1998.

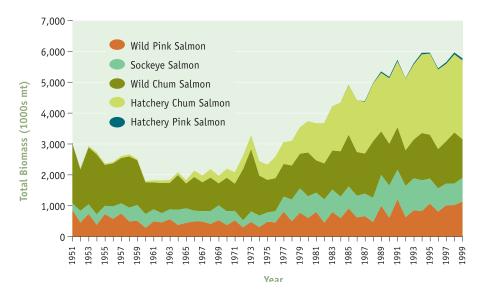


figure 1.2
Biomass of Pink, Chum and Sockeye
Salmon in North Pacific Ocean

Hatchery production has doubled the biomass of salmon in the North Pacific Ocean since the 1970s.

Credit: Eggers. 2002. Oceans and Watersheds Symposium Presentation. Anchorage, AK. The addition of hatchery fish may be able to overcome, to some extent, the loss of juveniles from predation and thereby increase the number of adults. However, in food-limited environments the addition of hatchery fish increases competition among juvenile salmon, reducing the number of fish that are able to reach critical overwintering size, and thereby reducing survivability of both hatchery and wild stocks in the area. Before management decisions can be made, it is

important to assess whether predation-based mortality or growth-based mortality is the primary factor in determining the number of salmon that will survive to adulthood.

Hatchery Impacts

Since 1951, hatchery production has doubled the biomass of salmon in the North Pacific Ocean, with most of this growth occurring since the early 1970s *(figure 1.2)*. Several studies have demonstrated that, as the biomass has increased, both the size and age of salmon at maturity have decreased.

The results of a study which analyzed data on the size of wild chum salmon returning to Fish Creek in Southeast Alaska and the Quilcene River in Washington State compared to Japanese and world hatchery production of chum salmon show a negative correlation between hatchery production of chum salmon and the size of male, wild chum salmon returning to both Fish Creek and the Quilcene River. These results suggest that while the limitations of "ocean carrying capacity" may not be apparent in the overall annual numbers of salmon, it may be apparent in the total weight, or biomass, of salmon produced annually.

The cap on total annual salmon biomass, or carrying capacity of the ocean for salmon, means that artificial increases in abundance from sources such as hatcheries or fish farms, could have negative impacts on some wild stocks of salmon in the form of reductions in production due to lowered growth potential and changes in age at maturity.

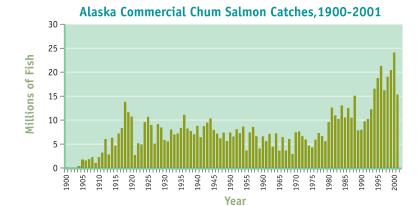
Support for the concept that reduced production of some wild chum stocks could occur as a consequence of lowered growth potential and changes in age composition of spawners comes from a long time series available for Prince William Sound, Alaska. The 20-year time series showed that, when the mean length of returning chum salmon was lower than average, survivability of offspring was indeed reduced.

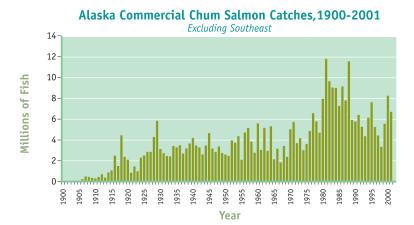
Sustainable Salmon Management

Most of the freshwater habitat essential to salmon production in Alaska remains in pristine condition, allowing salmon populations to flourish when ocean conditions favor high productivity. Relatively pristine habitats, sound management of salmon stocks and proactive protection of habitats during development of other natural resources have all contributed to maintaining quality salmon fisheries. The Alaska Department of Fish and Game was among the first management agencies in the nation to formally adopt protection of habitats and genetic diversity of stocks as salmon management principles (Sustainable Salmon Fishery Policy 2000).

Although a large proportion of Alaska's many salmon runs still exhibit high productivity, the status of salmon stocks varies geographically. Some salmon stocks have been significantly diminished; others are currently experiencing extreme variability in abundance; and still others appear to have been extirpated entirely. While overall chum salmon harvests in Alaska are at, or near historic highs, much of this increase can be attributed to chum harvests in Southeast Alaska, which are largely due to hatchery production. Figures 1.3a,b,c provide a graphic illustration of this situation. Figure 1.3a presents catch data for chum salmon throughout Alaska, while figures 1.3b and 1.3c show similar data for northern and southcentral Alaska combined and for the Yukon River drainage area alone. Formerly abundant chum salmon stocks in western Alaska have been in significant decline since the 1980s.

The reasons why some stocks appear to be increasing while others are decreasing are complex, having to do both with natural variation in stocks and with management decisions that affect salmon abundance. Alaska salmon management is moving into a new realm as the state continues to search for more effective salmon research and management programs to fully implement the provisions of the Sustainable Salmon Fishery Policy adopted in 2000. As Alaska's fisheries scientists watch and learn from threatened runs in Pacific Northwest fisheries and the demise of Atlantic salmon, some important shifts in salmon science are occurring that can lead to improved management.





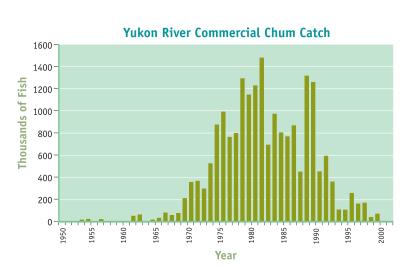


figure 1.3a,b,c Commercial Chum Catches from 1900-2000

Regional differences can be present even in seemingly healthy salmon populations. Credit: Eric Knudsen. 2002. Oceans and Watersheds Symposium. Anchorage, AK.



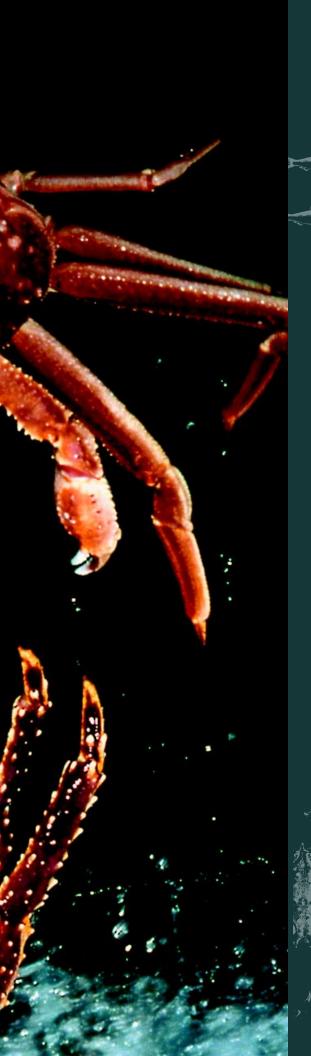
Until recently, fisheries management operated on the assumption that salmon stocks should provide harvest at predictable levels that correspond to past escapement levels through time.

To manage salmon stocks sustainably, it is necessary to recognize the scales of variability, both geographic and temporal, that influence salmon productivity throughout the salmon's life cycle. Under the previous management paradigm, salmon stocks within a watershed were treated as a single population. Current research in genetics suggests that individual salmon stocks may actually be composed of multiple unique spawning populations. It is theorized that specialized spawning populations evolve within a stock to maximize use of available habitat. Such evolutionary processes operate to create multiple populations within individual stocks and bring about differences among stocks. Observed and apparent differences among stocks in traits determining survival and growth such as ocean migration patterns, need to be taken into account when deciding whether to treat a salmon stock as a single unit, or as a collection of unique populations for management purposes. Approaches to fishery regulation such as setting levels of allowable harvest and spawning escapement goals need to be based on an understanding of differences in survival traits both within and among stocks.

Until recently, fisheries management operated on the assumption that salmon stocks should provide harvest at predictable levels that correspond to past escapement levels through time. That premise is now under challenge, with managers questioning how escapement goals are set and whether current approaches are really maximizing production of all the stocks and species of concern. Standard management practice has been to set goals based on historical productivity and observed sizes of salmon escapements. Using standard methods, in periods of changing productivity, such as occurred from the late 1970s to the early 1980s, escapement goals were not sufficient to take advantage of the conditions at the time. New modeling approaches consider various life history features, climatic and oceanographic conditions, natural variability and abundance within populations, and the effect of marine nutrients on freshwater carrying capacity. In addition, the potential impact of hatchery enhancement on salmon abundance and the natural limitations of the ecosystems into which the hatchery fish will be released now need to be considered in management decisions.







2. Variability in Pollock, Crab and Herring Populations

Panel Moderator:

Chris Oliver, Executive Director, North Pacific Fisheries Management Council

Predation as a Controlling Factor in the Groundfish Populations of the Eastern Bering Sea. *Jesus Jurado-Molina, University of Washington*

Recruitment-Mediated Control of Herring in Prince William Sound.

Brenda L. Norcross University of Alaska Fairbanks

Mechanisms of Climate Impacts on the Ecosystem.

Carol Ladd, Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration

How Crab Populations are Controlled by Climate-mediated Variability.

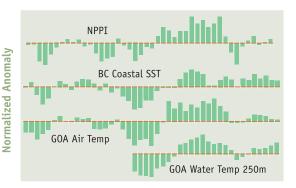
Gordon H. Kruse, University of Alaska Fairbanks

Bering Sea Groundfish Recruitment.

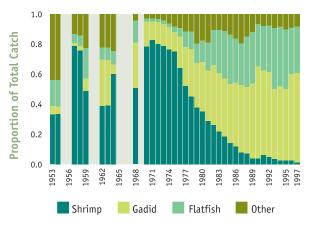
Nate Mantua, Joint Institute for the Study of Atmosphere and Ocean, University of Washington

The following is a synopsis of the above presentations and does not necessarily represent the views of individual panelists.

2. Variability in Pollock, Crab and Herring Populations



Changes in Air and Water Temperatures in the Gulf of Alaska



Variation in Small Mesh Trawl Catches in the Gulf of Alaska between 1953 and 1997

figures 2.1a, b

Note the complete transition in catches following the climate regime shift in the late 1970s when water temperatures (BC Coast SST and GOA water temperature) went from being colder than average to warmer than average.

Credit: Anderson and Piatt. 1999.

he complex of groundfish species is the most abundant of all fisheries resources off Alaska, totaling more than 21 million metric tons of biomass. Prior to the passage of the Magnuson-Stevens Fishery Conservation and Management Act in 1976, foreign fisheries accounted for most groundfish landings off Alaska. Since the mid-1980s however, the domestic groundfish fishery in Alaska has grown dramatically by replacing foreign and joint venture fisheries. In contrast, the fate of Alaska's shellfish fisheries has been much more variable. Some of the shrimp species have been severely depressed since the late 1970s, while crab populations have fluctuated through a series of highs and lows. Recent theory suggests that a shift in North Pacific ocean temperatures during the 1970s caused a change in overall biomass composition, with the amount of pollock and other groundfish increasing and the amount of shrimp and other forage fish decreasing (figures 2.1a,b).

Data indicate that as the populations of some species go up, others go down. A basic shift started with Alaska's groundfish and other marine fish in the early 1980s. Most of the groundfish species in the North Pacific increased at a significant rate during the 1980s, leveled off in the mid-1990s, and have remained at a fairly high level since then. Within that general aggregate pattern, some individual species are declining while others are increasing.

Biomass of pollock in the eastern Bering Sea and Pacific halibut throughout Alaska appear to be at near record levels, although biomass of pollock in the Gulf of Alaska has declined to pre-1977 levels. In both the Bering Sea and Gulf of Alaska, Pacific cod biomass has been declining steadily after achieving peak levels in the late 1980s. The biomass of many flatfish species showed a strong increasing trend in the 1980s and a moderate decreasing trend in the 1990s. Exceptions include Greenland turbot in the Bering Sea, which has declined steadily since the early 1970s, and arrowtooth flounder in the Gulf of Alaska, which remains near record levels of abundance after a dip in the late 1990s.

In common with other temperate and subarctic marine ecosystems, variability is largely attributed to fluctuations in recruitment, a dominant and natural feature of these marine populations. Recruitment is the amount of fish added to the stock each year due to growth and/or migration. Patterns in variability do exist, but determining the causes of population fluctuations is not simple, and subtle long term trends and patterns are often difficult to discern.

Pollock

Approximately 40 percent of the total U.S. commercial fishery landings by weight come from the Bering Sea. Walleye pollock is the dominant groundfish species in the Bering Sea in terms of biomass and catch. It plays important roles in the ecosystem as prey and predator in relation to other Bering Sea species. One of the important characteristics of Walleye pollock is its high rate of cannibalism, which is a mechanism by which the species controls its own population. Recent multi-species modeling efforts have demonstrated that cannibalism is the main

component of predation on pollock less than one year old, but less so for age one pollock, where several predators are involved. Pollock populations exhibit a classic predator-prey relationship: as the adult pollock population increases, the juvenile population decreases, and vice versa. This pattern has implications for fisheries management, since fishing at some levels and under certain climate scenarios may have a positive effect on recruitment by removing adult pollock that are the primary predators of age zero pollock recruits.

Climate also plays an important role in determining the abundance of pollock.

Studies conducted in the Bering Sea have shown that the timing of the retreat of sea ice

determines the timing of the spring phytoplankton bloom (figure 2.2). During cold periods, the phytoplankton bloom occurs early in the year and the timing of the bloom is disconnected from zooplankton predators. Because zooplankton are the primary food of juvenile pollock, this results in less food for juvenile pollock, lower juvenile survivability, and thus, fewer adults. This process, which is driven by the availability of food at the lower trophic levels, is referred to as a "bottom-up" process. During warm periods, the opposite is true. Larger amounts of phytoplankton and zooplankton result in larger populations of juvenile pollock and, eventually, a larger number of adults. Through cannibalism, the larger number of adults exerts a "top-down"

It appears that the system is thrown out of balance when there are extended warm or cold periods. During extended warm periods, the large pool of juvenile pollock results in a large number of cannibalistic adults feeding on them. This cannibalism exerts downward pressure on the juvenile pollock population. When the climate switches back to a cold regime, the combination of reduced food availability (decreases in phytoplankton and zooplankton) with this downward cannibalistic pressure creates extreme pressure on the

corresponding impacts on future adult populations (figure 2.3).

juvenile population. This causes a significant decrease in juvenile survivability, with

control on young pollock.

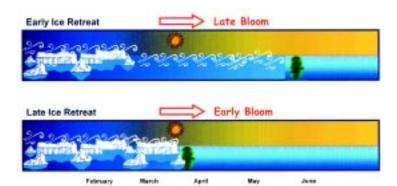


figure 2.2 Role of Ice and Wind in Determining the Timing of Spring Phytoplankton Bloom in the Bering Sea

Studies have shown that the timing of the retreat of sea ice determines the timing of the spring phytoplankton bloom.

Credit: Hunt, G. L., Jr., P. Stabeno, G. Walters, E. Sinclair, R. D. Brodeur, J. M. Napp, and N. A. Bond. 2002. Climate change and control of the southeastern Bering Sea pelagic ecosystem. Deep-Sea Res. II., in press.

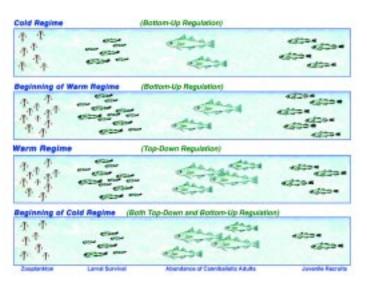


figure 2.3 Oscillating Control Hypothesis

Changes in ocean temperatures result in changes in juvenile and adult pollock abundance.

Credit: Hunt, G. L., and P. J. Stabeno. 2002. Climate change and the control of energy flow in the southeastern Bering Sea. Prog. Oceanogr., in press.

Model runs that simulate the timing and water temperature during the spring bloom over the past 50 years suggest that six of the eight coldest bloom temperatures occurred since 1989, which may indicate that the Bering Sea is currently in a cold regime where pollock productivity is controlled by bottom-up forces. These data also suggest that there is significant inter-annual variability in the Bering Sea that may play a stronger role than the regime shift variations that are hypothesized to be influencing productivity in the Gulf of Alaska.

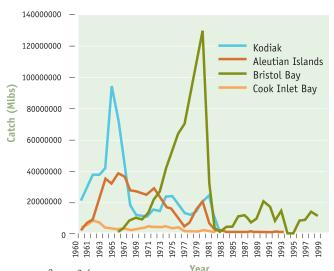


figure 2.4

Red King Crab Population Fluctuations,
1960-1999

Crab populations have peaked in different areas at different times.

Credit: Kruse. 2002. Oceans and Watersheds Symposium. Anchorage, AK.

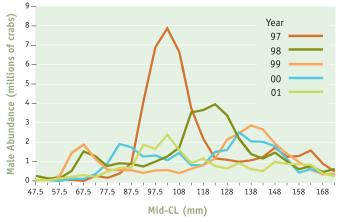


figure 2.5
Red King Crab Male Abundance,
Bristol Bay, 1997-2001

Natural mortality appears to have resulted in significant decline of crab stocks.

Credit: Kruse. 2002. Oceans and Watersheds Symposium. Anchorage, AK.

Crab

A suite of crab species is commercially fished in Alaska. Some of the more important species are red king crab, blue king crab, Dungeness crab, Tanner crab, and snow crab. Like other commercially important species, crab populations are also subject to significant variability. *Figure 2.4* shows the variability in commercial landings of red king crab at several locations from 1960 through 2000. Crab populations have peaked in different areas at different times. However, in most areas of the state, king crab fisheries have been closed since 1983 due to low abundance.

Several factors determine whether crab populations increase or decrease. One obvious factor is recruitment. Recruitment is defined as the number of young crab that enters the adult population. Crab populations will increase when the number of young crab added to the adult population exceeds the number of crab that is lost due to natural mortality or fishing. Likewise, the population will decrease if natural mortality or fishing pressure removes more adult crabs than are replaced by juvenile recruits.

Natural mortality in some instances, such as in the Bristol Bay king crab fishery in 1980 (figure 2.5), seems to have been catastrophic and resulted in the significant decline of crab stocks. The reasons for this are not clear. Data indicate that mortality occurred in crabs of all sizes and both sexes. Thus, this mortality cannot be explained by excessive fishing pressure, because fisheries are limited to the harvest of largersized males. The length of time it takes juvenile crabs to reach the legal size limit for commercial fishing depends on the crab species, rearing location, and other factors. Red king crab in Bristol Bay can take between six to nine years to mature to legal size from the time juveniles first settle on the sea bottom. Thus, strong year classes (high abundance) for crab species are formed long before fisheries for those crabs occur. This provides an additional argument for the assertion that the severe reduction in commercial catch of red king crab in Bristol Bay in 1980-81 was not the result of overfishing of crab stocks in the late 1970s, but rather, a result of a recruitment failure that occurred several years earlier. However, there were specific years in which harvest rates were excessive,

and there are several ways in which fishing can adversely affect crab populations, such as bycatch mortality or changes in size and sex structure.

Fisheries can also impact crab stocks through the stock recruitment relationship. Fairly strong evidence exists for density dependence in crab recruitment, especially for Bristol Bay red king crabs. When adult abundance is low, recruitment is also low; when adult abundance is high, recruitment remains low. The highest level of recruitment occurs in years when stock levels are intermediate. Research shows that the late 1960s and early 1970s were generally favorable for red king crab recruitment. However, recruitment declined during the 1970s and 1980s and remained low through the 1990s, with the exception of a single moderately strong year class in 1989-1990. Until 1967, Japanese and Russian fisheries dominated the king crab fisheries in the Bering Sea, but those fisheries were phased out in 1974.

While fishing may alter adult stocks sufficiently to adversely affect recruitment, environmental conditions appear to play a more important role in determining recruitment patterns of most crab populations. However, fishing may have larger impacts when crab populations are at low abundance after extended periods of recruitment failures. Accordingly, management plans now include lower harvest rates and fishery thresholds (stock levels below which fishing is not permitted) to mitigate adverse synergistic effects of fishing and unfavorable environmental conditions on declining crab stocks.

Recent research has examined the relationship between crab recruitment and changes in the physical environment, such as weather and ocean temperatures. For king crab, this analysis has focused on the relationship between recruitment and large scale weather events, such as the Pacific Decadal Oscillation (PDO). The PDO is associated with variability in sea surface temperatures in the North Pacific and is strongly coupled to the sea level pressure patterns and thus, to changes in near-surface winds. Under the warm phase of the PDO, the Aleutian Low Pressure system is intensified, resulting in stronger winds and enhanced vertical mixing of the upper ocean in the North Pacific. It is theorized that these stronger winds reduce the abundance of diatoms *(Thalassiosira)*, which are the preferred prey of king crab larvae, and thus, result in lower king crab recruitment.

For other species, such as Tanner crab in Bristol Bay, there is a weaker relationship between adult stock size and recruitment, and it is hypothesized that three physical features combine to influence recruitment: warm bottom temperatures may enhance gonadogenesis and embryo development; warm surface temperatures enhance production of the copepod *nauplii*, the preferred prey of Tanner crab larvae; and winds blowing from the northeast may favor settlement in offshore habitats with fine sediments where young crabs can bury to reduce exposure to benthic predators, such as Pacific cod.

Crab reproduction is extremely complex and investigations of crab recruitment remain in their infancy. In the next several years, dynamic simulation models coupled with both laboratory and field trials are expected to yield some more useful information on the relationships between recruitment and environmental factors. They may reveal more subtle ways in which fishing may alter crab reproduction.



Photo courtesy Susie Byersdorfer, Alaska Department of Fish and Game. 2002.

While fishing may alter adult stocks sufficiently to adversely affect recruitment, environmental conditions appear to play a more important role in determining recruitment patterns of most crab populations.



Herring

For herring, good survival depends on survival variability at each growth stage. The challenges that individual fish encounter throughout their life cycle are immense. Survival is dependent on multiple factors: number of adults, water movement, currents, predation, waves, food, temperature, disease, and more.

The juvenile stage for herring, especially the first year, is very important for determining survivability to adults. Juvenile herring survival is higher when there are more adult (age 4) herring to spawn. Spawning time is mid- to late April in Prince William Sound. One female herring will lay 20,000 to 50,000 eggs. Eggs are deposited in intertidal and shallow subtidal areas, with egg mortality caused by waves, currents, bird predation, and

dehydration. Approximately 24 to 45 percent of the eggs laid survive to hatch. Additional mortality occurs within the first five days of hatching as larvae that are physically or genetically defective die off. Natural factors are often responsible for these defects, but they can also be caused by human activities, such as oil spills.

During the late spring and early summer, currents carry the juvenile herring from the hatching areas to the nursery grounds, usually in semi-enclosed bays. Research has estimated that only one to seven percent of the larvae survive to reach the nursery areas. The herring remain in the nursery areas through October to feed, where they are also preved upon by many species of birds, fish and mammals. This predation can reduce the population by an additional 79 to 99 percent. Survival through the winter depends on how much food the larvae are able to consume before November, how large they are going into the winter, and the conditions of the particular bay. Winter survival is highly variable, ranging between five and 99 percent (figure 2.6).

The foregoing discussion provides some indication of the natural mortality in herring populations through the first year. It is estimated that for each million herring eggs laid, between one and 6,500 will survive the first year. Thus, the large number of natural factors impacting herring survival complicates management of herring stocks. In addition, human factors, such as fishing pressure and pollution, add additional complexity and variability to management decisions. Because the natural factors are beyond their control, fisheries managers have focused on protecting the adult spawning biomass as the best way to protect the herring population.

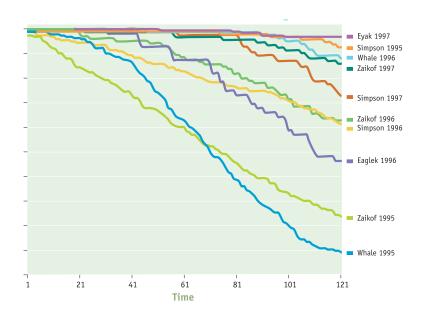
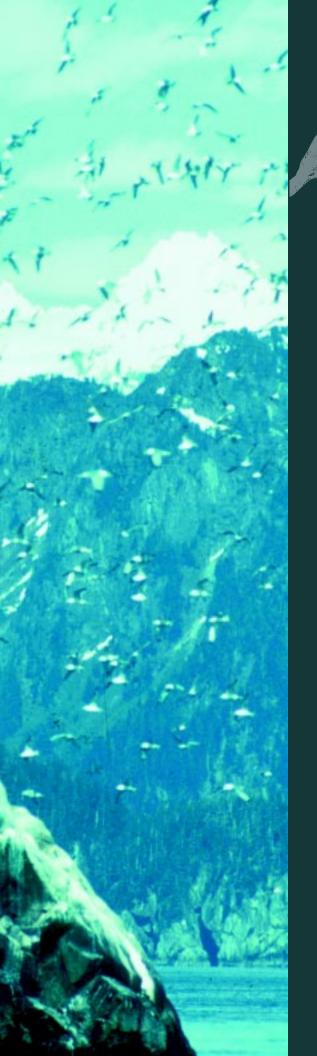


figure 2.6 **Over-Winter Survival of Pacific Herring**

Overwintering energetics model predicts proportional total over-winter survival of Pacific herring for various locations in Prince William Sound.

Credit: Norcross, 2001. Fisheries Oceanographer, Vol. 10, Supplement 1.





3. Changing Bird and Mammal Populations in Alaska

Panel Moderator:

David Irons, Alaska Seabird Coordinator, U.S. Fish and Wildlife Service

Factors That Can Cause Changes in Marine Bird Populations.

Vernon Byrd, Alaska Maritime Refuge

Why is Anyone Surprised that Steller Sea Lions Have Declined in Western Alaska? Lloyd Lowry, Alaskan Biologist and Fisherman

Seabirds, Forage Fish and Marine Ecosystems.

John F. Piatt, Alaska Science Center, U.S. Geological Survey

That is My Garden.

Caleb Pungowiyi, Robert Aqqaluk Newlin Sr. Memorial Trust

The following is a synopsis of the above presentations and does not necessarily represent the views of individual panelists.



3. Changing Bird and Mammal Populations in Alaska

shift in ocean climate, reflected by temperature changes during the late 1970s, is believed to have played a significant role in changing the composition of the fish and invertebrate communities in the Northern Gulf of Alaska from a system dominated by shrimp and forage fish to one dominated by pollock, cod and other groundfish. During the transition, trawl catch biomass declined by half, but recovered to pre-transition levels by the late 1980s. These changes may be partly responsible for some of the changes that have occurred and are continuing to occur in marine predators such as seabirds, sea lions and other marine mammals.

Many factors influence populations of marine predators, and they operate over a wide range of temporal and spatial scales. Since it is difficult to study marine mammals and

seabirds at very large spatial scales, most research is conducted when species come together in feeding and reproductive aggregations and are easily counted and observed. As a result, much of the life history data on these animals has been collected from only a few areas and during relatively short time periods.

Even at small spatial scales, it is difficult to measure how changes in the type and availability of prey affect aggregation behavior and foraging success of marine predators. Foraging takes place under water and is difficult to observe. In addition, for many marine predators (particularly large mammals) it is generally not feasible to collect individuals and determine what they have been eating. As a result, it is not easy to answer questions about the extent to which fishery reductions influence the density of prey species and whether or how they adversely impact marine predators.

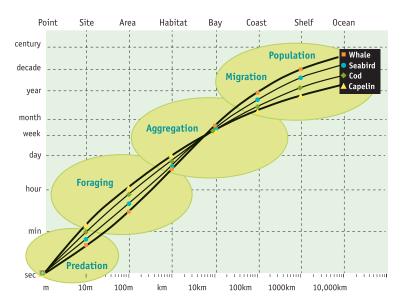


figure 3.1

Spatial and Temporal Scales for Studying Marine Predators

Populations of higher vertebrates such as seabirds, whales and other marine mammals take years or decades to increase or decline in response to environmental changes, and the factors that cause these changes may function over scales of meters to thousands of square kilometers.

Credit: Piatt. 2002. Oceans and Watersheds Symposium. Anchorage, AK.

Birds

Indicators of change

Seabirds are often used as indicators of marine ecosystems because they are relatively easy to study, are widespread, and gather in large multi-species colonies, so that inferences can be based on more than one species. Research conducted following the *Exxon Valdez* oil spill has contributed to understanding the way in which seabird populations are regulated by food supply. Water temperatures and local oceanography can markedly influence the geographic distribution and abundance of different forage species. Similarly, water temperatures may influence the depth distribution of prey, which in turn may affect where

and how deep seabirds and marine mammals need to dive in order to obtain food.

Different bird species react differently to changes in the density of their prey. Kittiwakes for example, exhibit a strong functional relationship between fledgling success and prey density: when food is scarce, kittiwakes fail to produce fledglings; when food is abundant and above a certain critical threshold, kittiwake fledgling success is high and independent of further fluctuations in prey abundance. With common murres, on the other hand, the relationship between food abundance and fledgling success is not strong. Murres are able to adjust their foraging behavior in response to changes in food supply, so their time budgets provide a better measure of variability in food.

Because there is a strong relationship between food abundance and fledging success in kittiwakes, historical records of breeding success can be used to evaluate past decadal changes in the overall marine ecosystem. Research has shown that before the 1970s, kittiwakes were rarely deprived of food or limited by food. In the 1980s, the number of kittiwake colonies exhibiting breeding failure increased dramatically. Some improvements in fledgling success in the Gulf of Alaska and the Bering Sea were observed in the 1990s, but foraging conditions are apparently far inferior to those of the 1970s. The relationships between prey density and marine predator success are probably mostly nonlinear, and different animals have different thresholds (*figure 3.2*).

In addition to large scale changes in the ecosystem, changes in marine bird populations also can be caused by other factors that can affect birds both at nesting sites on land and on their marine feeding grounds. In Alaska, these are primarily introduced species on islands, contaminants, and fisheries, particularly bycatch of seabirds themselves.

Introduced species

The two most serious predators of seabirds and other marine birds on Alaska islands are foxes, particularly Arctic foxes, and Norway rats. Arctic foxes were introduced for commercial fur harvesting on as many as 450 islands throughout Alaska in the 1930s and earlier. The growing fox populations had a devastating effect on local bird populations, in some cases leading to local extirpation of individual species. In the 1950s an active program was initiated to remove foxes from the islands of the Alaska Maritime National Wildlife Refuge. The removal of foxes from 38 islands to date has led to an increase in some marine bird populations in this area.

Norway rats were also introduced on a number of islands in Alaska beginning in about 1800. Rats have always been notorious stowaways on ships, and most rat populations on Alaska islands started with rats escaping from ships that ran aground or visited these islands. Norway rats have a profound negative impact on populations of marine birds, with certain species, such as the red-legged kittiwake, being especially vulnerable to rat predation. Today, a number of islands that formerly supported seabird populations are infested with rats, and seabird populations on these islands as a result, have declined dramatically.

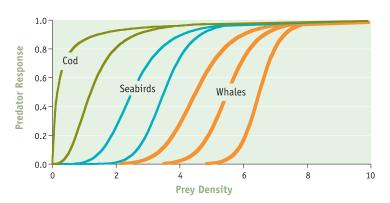


figure 3.2

Theorized Relationship between Prey and Density and Predator Populations

When prey densities fall below threshold levels, populations decline abruptly; when prey densities increase above threshold values, predator populations also increase.

Credit: Piatt. 2002. Oceans and Watersheds Symposium. Anchorage, AK.



With recent improvements in technology and techniques for monitoring the spread of persistent organic pollutants, it is hoped that more information on their effects will be known in the near future.

Contaminants

In addition to introducing non-indigenous species, boat and ship traffic also has the potential to result in oil spills and chronic oiling. Both oil spills and dumping of oily bilge water can cause significant mortality of marine birds. As a result of past oil spills and continuous bilge water dumping, marine birds are being exposed to chronic oiling in Alaska. It is not clear to what extent this continuous, low-level oiling adversely impacts marine bird populations, but it is potentially significant.

Airborne persistent organic pollutants are also a concern for marine bird populations. The extent of the impact is not known, but some transport of these pollutants through the food web is likely. With recent improvements in technology and techniques for monitoring the spread of these pollutants, it is hoped that more information on their effects will be known in the near future.

Other contaminants can also significantly affect marine bird populations at a local level. Lead poisoning from the ingestion of lead shot left in wetlands as a result of hunting has been a particular problem for both the spectacled eider and the Steller's eider. Because the impacts are localized, it is unlikely that lead poisoning is a significant contributor to overall marine bird declines.

Fisheries

Fisheries are known to have mixed effects on marine bird populations. For gulls, particularly glaucous-winged gulls, the discards from fisheries may have provided supplemental food and possibly caused populations to increase. This population increase may be causing ecosystem-level impacts as a result of competition between gulls and other birds that use the same nesting areas. Alaska Natives who depend on seabirds and eggs for subsistence food are concerned that the increase in glaucous-winged gull populations is having a negative impact on populations of other bird species. These gulls are proficient predators that prey upon the young of other gulls and many other bird species.

For other bird species, fisheries may have had significant impacts on populations through direct mortality. For example, in the early to mid-1970s, the Japanese high seas drift gillnet fishery for salmon operating in the Bering Sea and close to the Aleutian Islands is believed to have resulted in five million seabird deaths over a 20-year period. The passage of the Magnuson-Stevens Fisheries Conservation and Management Act in 1976 ended this fishery near Alaska, but it continued west of 175° W in the Aleutian Islands until the late 1980s. The use of drift gillnets was banned under international treaty in 1994. Since that time, populations of murres, puffins and fulmars have been increasing in western Alaska.

Longline fisheries and nearshore gillnet fisheries can also contribute to marine bird mortality. Fulmars and albatrosses are particularly vulnerable to accidental hooking by longlines as they are deployed off the boat, while diving birds such as Kittlitz's murrelets and common murres are susceptible to being caught in nearshore gillnets. Because of the impact of longline fisheries on the endangered short-tailed albatross, significant research and effort have been invested in reducing bycatch of marine birds from longline fisheries, with some positive effects.

Mammals

Marine mammal populations in Alaska are undergoing changes, with populations of some baleen whales increasing while populations of Steller sea lions have been declining. Marine mammals are long-lived species: their populations take decades to grow and in natural circumstances they would be expected to decline slowly. As a result, impacts that occur during a single breeding season may not become evident in the population for several years or decades. One example of this may have occurred as a result of the early loss of sea ice off western Alaska during 1996 and again in 2001. Alaska Natives reported the stranding of numerous juvenile seals, believed to be associated with the premature breakup of the ice pack. How this will affect populations of these species in the future is not known.

As apex predators, marine mammals are in competition with humans for fish. Marine mammals and fisheries compete and interact in several ways with significant impacts: a fishery can remove marine mammal prey (such as groundfish); it can remove the food of marine mammal prey (forage fish); or a fishery can remove the competitor for a marine mammal (for example, Pacific halibut and sea lions share similar diets).

In their natural state, marine ecosystems do not contain excess biomass that can be harvested by humans through fisheries without some type of corresponding impact to the other predators that would use that biomass. Groundfish fisheries in the Bering Sea remove about two million metric tons of groundfish each year, and similar fisheries in the Gulf of Alaska remove on the order of 200,000 metric tons. According to the data and models used by fisheries managers, the fisheries have reduced pollock stocks in the Gulf of Alaska by 74 percent over what they would be without fishing, and by 55 percent in the Bering Sea. Marine mammals, such as Steller sea lions, compete directly with commercial fisheries for these valued resources. The annual amount of groundfish removed by fisheries from the Bering Sea is equal to the annual food requirements of about 300,000 Steller sea lions (6.4 metric tons per sea lion per year) and it's not available to be eaten by Steller sea lions, or other non-human predators. Because of this competition, researchers are concerned that fisheries have reduced the availability of prey for some marine mammals, and fisheries may therefore be having an adverse impact on marine mammal populations (*figure 3.3*).

Effects on Indigenous People

Many coastal communities in rural Alaska are dependent on the ocean for food, which is important to a subsistence, cultural, and sharing lifestyle. Because people in these communities use these resources, they are keenly aware of changes in these resources around their villages. Subsistence harvest data could be used as an indicator of relative abundance of some marine bird and mammal species. People in coastal villages are concerned about changes in the ocean ecosystem because, when changes that occur in the oceans cause declines in the animals that people eat, these coastal communities suffer.

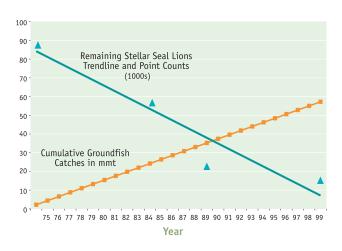


figure 3.3
Comparison of Groundfish Catches
and Steller Sea Lion Population Numbers

Credit: Lowry. 2002. Oceans and Watersheds Symposium. Anchorage, AK.



Sea lions.

Photo courtesy Alaska Division of Tourism.





4. Impacts of Contaminants on Alaska's Wild and Traditional Foods

Panel Moderator:

Michele Brown, former Commissioner, Alaska Department of Environmental Conservation

Community Partnerships and Concerns. *Patricia Cochran, Alaska Native Science Commission*

Impacts of Persistent Organic Compounds and Heavy Metals on Traditional Foods and Alaska Native Health.

James E. Berner, Alaska Native Tribal Health Consortium

Challenges in Managing, Monitoring and Interpreting the Impacts of Contamination on Wildlife and Traditional Foods.

Todd O'Hara, Department of Wildlife Management, North Slope Borough

Contaminants in Seafood: Marketing Consequences and their Repercussions for Alaskans.

Randy Rice, Alaska Seafood Marketing Institute

The following is a synopsis of the above presentations and does not necessarily represent the views of individual panelists.



4. Impacts of Contaminants on Alaska's Wild and Traditional Foods

ild and traditional foods are the dietary and cultural lifeblood of Alaska's indigenous people and the backbone of the Alaska economy — from commercial and sport fishing to tourism. For Alaska Native communities the statewide average annual harvest of wild foods is 400 pounds per person, rising to 600 pound per person in some remote areas. Fish, especially salmon, make up the majority of this harvest (figure 4.1). Alaska Natives eat six and one-half times more fish than other Americans. Traditional foods provide inexpensive and readily-available nutrients, anti-oxidants,

calories, and high-quality protein. These traditional components protect against diabetes and cardiovascular disease and improve maternal nutrition and neonatal and infant brain development. In most rural Alaska communities often there is no comparable, accessible and economically feasible alternative for traditional foods.

Southwest/ Aleutians kg/person/year kg/person/year Marine Mammals Other (birds, shellfish, plants)

figure 4.1

Total and Composition of Subsistence for Small and Mid-side Communities in Selected Areas of Alaska

For Alaska Native communities the statewide average annual harvest of wild foods is 400 pounds per person, rising to 600 pound per person in some remote areas.

Credit: Arctic Monitoring and Assessment Programme, AMAP Assessment Report, Arctic Pollution Issues, Fig.5.5. 1998.

Presence of Contaminants

The correlation between environment and human health is particularly important when it comes to wild and traditional foods. Potentially harmful contaminants are being found in Alaska's air, water, fish, plants, and wildlife. The most serious of these contaminants are persistent organic pollutants (which include the pesticides aldrin, endrin, chlordane, DDT, heptachlor, mirex, toxaphene, and hexchlorobenzene), PCBs, and dioxins and furans, as well as heavy metals, including mercury, cadmium, and lead.

These contaminants reach Alaska primarily by atmospheric and ocean transport. Persistent organic pollutants and heavy metals remain in the environment long after they are released and move from air and water into soil, plants, animals, humans, and eventually into the food web. Persistent organic pollutants accumulate in fat, whereas heavy metals generally accumulate in organs and muscle. Adverse effects from exposure can result in reproductive, immunological, neurological, and developmental effects and cancer.

Health Effects

While traditional food has a long and robust health literature to support its beneficial effects, there is little research on the effects of potential contaminants in these kinds of food on human health at low levels of exposure. This lack of information, added to the fact that rural Alaskans are exposed to mixtures of these contaminants, makes it very difficult to discern the effect of any specific agent on human health or to provide adequate information to communities on the risks associated with eating traditional foods that may contain chemicals of concern. Contaminant levels have been measured in small studies of selected Alaska Natives. One study analyzed age and gender relationships to PCB concentration levels demonstrating increased levels with age (*figure 4.2*). Because these sample sizes were very low, few conclusions can be drawn and broader research is needed to answer key questions and address community concerns.

In the U.S., research on the health effects of contaminants in traditional foods has been uncoordinated and undirected, creating confusion within rural communities on whether traditional foods are safe to eat. Even though contaminants may not cause detectable morphologic or physiologic diseases in food sources, the knowledge of their presence has a profound impact on the way that Native people view the ecosystem and their interactions with wildlife. Some Alaska Natives have begun avoiding certain traditional foods or have stopped eating certain parts of foods, such as internal organs, because of knowledge that the foods contain contaminants.

In 1997, the Arctic Monitoring and Assessment Program, composed of ministers from the eight arctic rim countries including the U.S., issued its first report highlighting the risks posed to human health and wildlife from persistent organic pollutants. The recommendation from this report was that native peoples should continue to use the traditional foods and to breast-feed infants. When traditional foods, or economically feasible alternatives of equal nutritional value, are not available or are not consumed, Alaska Natives tend to consume more saturated fat and inadequate amounts of key nutrients. Health experts have concluded that the well known benefits of breast feeding and a traditional diet outweigh suspected, but not fully understood, effects of contaminants.

Developing fetuses and children are the main concern for low level, chronic exposure to contaminants. Adverse health effects are more likely to be discernible in fetuses and children than in adults. Mercury levels in women and children from the Yukon-Kuskokwim Delta and North Slope participating in the Arctic Monitoring and Assessment Program Human Health Maternal/Infant Monitoring Program averaged 6.1 micrograms per liter of maternal blood. The level of concern for mercury established in Canada is 20 micrograms per liter of maternal blood, indicating that exposure levels in the study participants were relatively low. In contrast, the benefits from breast feeding are known to be significant. For example, a study conducted in the same area showed that the risks of severe respiratory syncytial virus infection were greatly reduced by breast feeding. This virus can be extremely dangerous to Alaska Native infants.

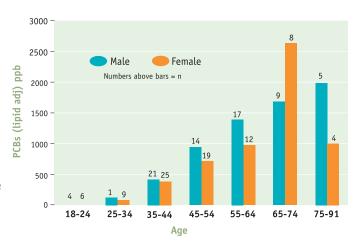


figure 4.2
PCB Levels — Gender Specific

Distribution of serum PCB concentrations in Aleutian volunteers are related to participants' age and gender.

Credit: Middaugh et al. 2000.

Persistent organic pollutants and heavy metals remain in the environment long after they are released and move from air and water into soil, plants, animals, humans, and eventually into the food web.



Photo courtesy Alaska Division of Community & Business Development.

Research Needs

More research is needed on the impacts of environmental contaminants on humans. Currently, contaminant concentrations measured in tissues of wild animals do not allow for interpretation of the health effects on humans that consume those animals. Determining concentrations in biota could address long term trends, but it will not address the question of whether eating these animals is safe. An understanding of natural variability is also critical for interpretation of the data being collected. For many animal populations there is insufficient information to know what constitutes a healthy population and how to draw inferences on the health effects of contaminants on specific species or groups.

Alaska Natives observe changes in the lands and the health of the animals as they go about their daily activities. For this reason it is critical that the end users, the people who most need the information, be involved in designing and implementing studies to assess the health effects of contaminants. Research results need to be presented in a manner that will help rural Alaskans make informed choices on what foods they should be eating and whether the presence of contaminants outweighs the overall benefits of a traditional diet. Native communities need to be involved on every level, including tracking exposures and effects, evaluating risks and benefits, and strengthening educational outreach.

Marketing Messages

Rural Alaskans are not the only people who eat Alaska wild foods. Alaska fishermen supply 89 percent of the world's wild salmon and 28 percent of the world's commercial seafood harvest. Information on possible contaminants in wild foods must be presented in a manner that puts the issue into a larger context. For example, a 1988 scientific paper reported that organochloride contaminants had been found in sockeye salmon off Alaska. This report specifically stated that the levels of this contaminant were well below the levels of concern for human consumption, and further, that these levels are 10 times lower than those found in salmon in the Baltic Sea and 20 times lower than salmon from Lake Ontario. In spite of this, a newspaper headline read, in part "... toxins catch a ride on salmon: migrating fish bring back pollutants, study finds." Situations like this can cause consumers to stop purchasing Alaska seafood. The perception of the Alaska seafood in the marketplace has a direct link to the economic health of coastal and rural communities in Alaska which, in some areas, depend almost exclusively on commercial fishing.

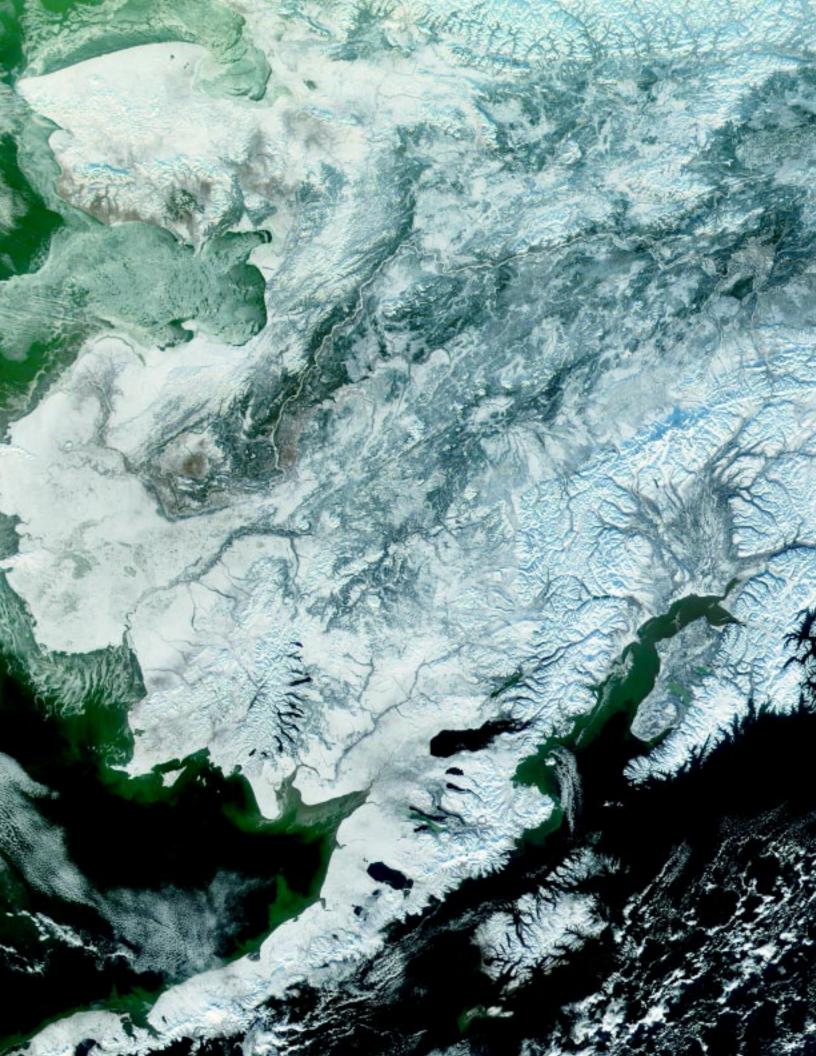


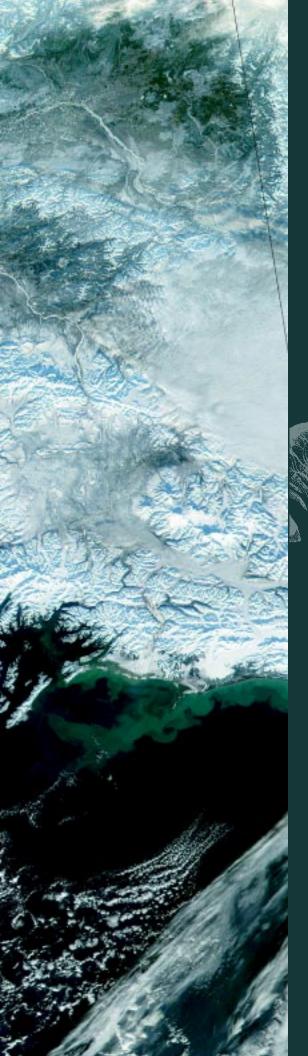
What's Being Done

The Alaska Department of Environmental Conservation has implemented a fish safety monitoring program that will sample several species of fish at 21 locations throughout the state. The program will help identify current levels of over 135 individual chemicals including heavy metals, pesticides, PCBs, dioxins, furans, and brominated fire retardants. This information will be used to determine the baseline level of contaminants so that the department can track trends. The data from the study will also be compared to federal action levels for each of the contaminants, and this information reported back to communities. The department is also developing a state strategy to begin monitoring contaminant sources, with recommendations for reducing or eliminating exposure from these sources.

An organized approach is needed to properly evaluate the real risks posed by these contaminants to human health. The Alaska Department of Environmental Conservation is working with partners to form a new paradigm for collaborative research and monitoring on wild and traditional foods. The goal is to implement a wild and traditional food safety program modeled after the Canadian Northern Contaminants Program. This program is a collaboration among the Canadian Department of Indian Affairs, other federal agencies, territorial governments, aboriginal organizations, and universities. The aim of the program is to reduce and, where possible, eliminate contaminants in traditionally harvested foods, while providing information that assists informed decision-making by individuals and communities in their use of foods.

An organized approach is needed to properly evaluate the real risks posed by these contaminants to human health.







5. Furthering Ecological Knowledge with Changing Technology

Panel Moderator:

Vera Alexander, Dean, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks

Advances in Deep Sea Technology.

Marcia McNutt, Monterey Aquarium Research Institute

New Jersey Shelf Observing System.

Scott Glenn, Institute of Marine and Coastal Sciences, Rutgers University

Electronic Tagging and Tracking in Marine Fishes.

Jennifer L. Nielsen, Alaska Science Center, U.S. Geological Survey

Using Remote Sensing Information to Study Alaska's Oceans.

S. Lyn McNutt, Geophysical Institute and Institute of Marine Science, University of Alaska Fairbanks

The following is a synopsis of the above presentations and does not necessarily represent the views of individual panelists.

(photo left)

Satellite image taken on November 7, 2001 with clear skies over Alaska. Cook Inlet appears flooded with sediment, turning waters muddy brown. Across the Aleutian Range of the Alaska Peninsula, the bright blue and green swirls indicate phytoplankton populations.

Credit: Jacquwa Descloitres, MODIS Land Rapid Response Team, NASA/GSFC.

5. Furthering Ecological Knowledge with Changing Technology

any new technologies developed previously by industry can provide the oceanographic community with the capabilities necessary for the next generation of observational and decision-making solutions. Adaptation of these technologies requires only small incremental investments from the marine science community to apply new cuttingedge strategies to the needs of Alaska's coasts and watersheds. A description of some of the new technologies presented at this meeting follows:

Moorings

Oasis moorings are solar-powered and fitted with a microwave transmitter that allows two-way, real-time communications with the shore. These moorings use physical, chemical and biological sensors located from the surface down to several hundred meters depth to identify and monitor seasonal fluctuations, climate changes, and annual variability in the ocean. These measurements, in turn, provide the information necessary to study climate regime shifts that might affect the ocean environment, such as El Niño.

Data from this type of mooring have been used in Monterey Bay, California, to distinguish times when the ocean is colder and more productive versus times when it is warmer and less productive. For example, an observed temperature increase of $+0.4^{\circ}$ C in Monterey Bay resulted in a 25 percent decrease in primary productivity for the region, which then affected the habitat of the bay.

Autonomous underwater vehicles

The current generation of autonomous underwater vehicles (AUVs) can execute complex, preprogrammed missions; they can go where remotely operated vehicles and human operated vehicles are unable to travel. Considering the low cost of these AUVs, these capabilities make the Odyssey class vehicles very effective to use in many types of oceanographic studies.

As an example, a Dorado-class AUV recently traveled under the Arctic Ocean as part of the Altex Project. The objective was to track the intrusion of warm, saline Atlantic water through Fram Strait and into the Arctic Ocean, recording the increased ice melt occurring due to this warm water intrusion. This exchange of Atlantic water is believed to be a result of global warming, and may have drastic consequences for the world's climate. The AUVs obtained a more dense sampling, at lower cost, and more quickly than could be achieved using the more traditional data collection method, an ice breaker.



Woods Hole Oceanographic Institute's (WHOI) autonomous underwater vehicle (AUV) *Benthic Explorer* being deployed.

Photo courtesy WHOI.

New sensors and sampling technologies

There are new sampling technologies which allow for continuous observation from AUVs and *in situ* moorings. Now, an environmental sampling instrument on a mooring or an AUV, combined with an on-board processor can take water samples on a preprogrammed schedule, analyze the samples, then send the results to a shore-based terminal. An example of the use of such instrumentation is the near-real-time detection of a harmful algal bloom, such as a Red Tide.

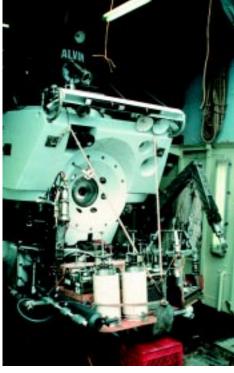
Ultraviolet spectrometers offer another type of new instrument using innovative information retrieval. These spectrometers are often deployed to sniff out hydrogen sulfide at cold seeps on the ocean floor, where they detect several different chemical compounds, using the absorption spectrum of ultraviolet light to determine the chemical species present in the ocean. The primary benefit of these *in situ* sensors is that analyzed information, not raw data, is sent back to the lab, thus facilitating data management, increasing information content, and lowering costs. This allows researchers and decision-makers to obtain answers to important issues in critical areas in near-real-time, without the expense of field programs.

Tagging technology

New electronic tagging technology will allow scientists to undertake comprehensive studies of marine ecology and ecosystem dynamics, not possible with older approaches.

This innovative new electronic tagging system has been used in a significant number of recent studies on: sharks, ocean-caught salmon, halibut, black cod, king crab, and coho salmon smolt. The tagged information includes data on temperature, water pressure, distribution, movement, stock identity, habitat, and predator-prey dynamics. These are all key parameters for understanding and modeling ecosystem dynamics.

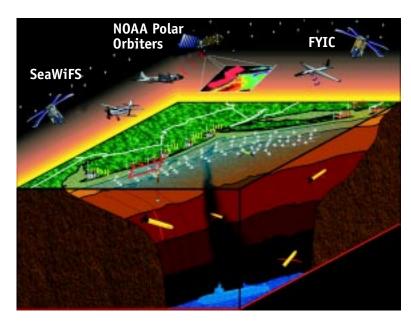
Alaska is now collaborating with the International Pacific Halibut Commission to undertake more extensive halibut surveys due to the success of this tagging technology. A new tagging study will look at halibut life history patterns, seasonal movements and migration in the Gulf of Alaska. External tags will be anchored to the animal through a tether. An onboard computer will collect and retain the data and, at a preprogrammed time, a tungsten tip will corrode, detaching the tag from the animal. The tag floats to the top of the ocean, allowing the antenna to download the data from the tag to an ARGOS satellite. The data then arrive at the researcher's office, without the traditional need to recapture the tagged fish.



Submersible vehicle *Alvin* loaded for sample collection.

Photo courtesy OAR/National Undersea Research Program (NURP); Rutgers University.

Adaptation of these technologies requires only small incremental investments from the marine science community to apply new cutting-edge strategies to the needs of Alaska's coasts and watersheds.



New Jersey Shelf Observing System, Rutgers University, Coastal Ocean Observation Laboratory. The Long-term Ecosystem Observatory (LEO) of the New Jersey coast serves as one prototype for regional coastal observations of the future. Credit: Rutgers http://marine.rutgers.edu/mrs.

Observational Programs for Coastal Regions

New Jersey has some of the nation's first industrialized watersheds and some of the nation's most developed beaches. The Long-term Ecosystem Observatory 15 (LEO-15), is part of Rutgers University's observing system off the New Jersey coast. LEO-15 is one of the most comprehensive and complex

interactive systems in the world, designed to answer specific questions related to coastal environments in heavily populated regions, and to provide information to operational and recreational users as well as researchers and decision-makers. Implementing this type of observational system requires the simultaneous operation and analysis of multiple sensors: satellites, aircraft, small and large boats, AUVs, and gliders, all with the goal of developing a real-time capability for rapid environmental assessment and physical/biological forecasting in coastal waters. Having the majority of the data available in real time allows for adaptive sampling of episodic events and assimilation into ocean forecast models.

Despite the wide variety of communications technology necessary in LEO-15, the project emphasizes bringing people and technology together. The operational environment for the project is called the Skunk Works model, a collaborative effort bringing together researchers in one location, a unique environment for academic research. In this shore-based location, data from all the instruments are online and viewable; information can be seen by the general public, military, government and recreational users, and commercial fishermen. This systems approach, or what is now called "operational oceanography," provides information that is useful in near-real-time, allowing for timely forecasting of ocean conditions on the human scale.

The LEO-15 system has operated during four annual coastal predictive skill experiments, from 1998 through 2001. Participants report that for an observational program of this nature to succeed, it must be sustainable, well-integrated, and able to create data sets that can be assimilated by modelers. The project is part of the expanding network of ocean observatories that will form the basis of a national observation network. These regional efforts will eventually be linked, and their combined data will be available through a network of virtual labs capable of rapid data visualization and dissemination of information. Alaska plans to implement an observational system as part of the U.S. and International Ocean Observing Systems under the guidance of CAOS (the Coastal Alaska Observatory System).



Creating Information from Data

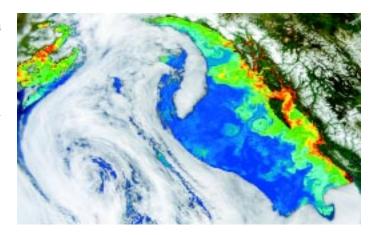
Alaska is data rich and information poor. Data and information, however, are not the same. Remote sensing data offer a potentially rich source of information for the oceanic community by observing ocean waves, sea surface winds, eddies, chlorophyll, sea ice, nearshore areas (including coastal erosion and turbidity), sea surface temperatures, clouds, water vapor, aerosols, pollutants, radiation, and particulates. These data are underused, particularly in Alaska. The prevailing approach is for researchers to collect and archive data, use it to investigate hypotheses and problems, and publish results of their analyses. Unfortunately, the process of turning data into useful information often ends after the study is completed, with data placed in archives, and not turned into routinely available, value-added information products. Potential users, especially decision-makers, policy analysts and the general public, are frequently not equipped to take raw data sets and turn them into usable information.

One factor that makes Alaska so data rich in remote sensing is its location. Most Earth observing satellites are in a polar orbit; they collect and downlink more information at the poles. Alaska has the distinction of being the only high-latitude satellite data acquisition facility in the United States, which means that it collects a wealth of data every day. Unfortunately, most of the data currently collected are underused, and may not even be processed within the state. Many of the existing data archives are not used to study important state issues.

A baseline strategy is needed where information products are produced routinely from raw data collected in Alaska, and then archived and made available to a wider audience. Another long term need exists to synthesize data from multiple sensors and auxiliary information and thereby provide information products that answer specific user needs and questions.

The time is right for Alaska to work toward an effective program for acquisition, archival, retrieval, integration, analysis and distribution of data to serve Alaska marine research and observations. The University of Alaska hopes to address some of these issues by devising an endto-end "data as information" strategy to facilitate the use of remote sensing and other geospatial data. This strategy will be based mainly on resources available through the University of Alaska system, and will be designed to serve both the University's research and educational requirements and the State of Alaska's needs. To begin this process, we need to determine who needs what information, when they need it, and how they want to receive it. By understanding the functional needs of each user group we can target appropriate technological solutions, instead of defining needs by technology.

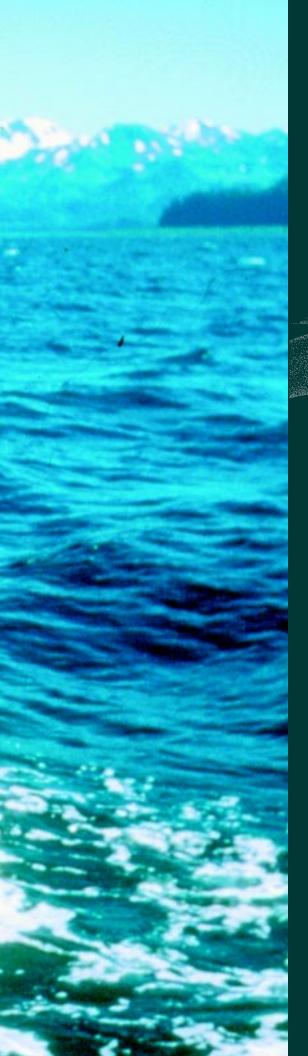
The end-to-end strategy will pull together several existing and planned activities including: the Geographic Information Network for Alaska (GINA), the International Observatory of the North (ION), the Arctic Region Supercomputing Center (ARSC), and the Coastal Alaska Observatory System (CAOS). These will be combined through the thematic research interests of the University: Ocean Sciences, Terrestrial Sciences, Atmospheric and Space Sciences, and Human Dimensions.



The bright red, green and turquoise patches to the west of Alaska's Alexander Archipelago and British Columbia's Queen Charlotte Islands highlight the presence of high concentrations of chlorophyll found in phytoplankton. The eddies visible are formed by the strong outflow currents from

Credit: SeaWiFS Project, NASA/Goddard Space Flight Center and ORBIMAGE.





6. Perspectives on Ecosystem-based Management

Panel Moderator:

Clarence Pautzke, Executive Director, North Pacific Research Board

Scientist Perspective.

George Hunt, University of California Irvine

Implementing Ecosystem-based Management of Fisheries.

David Fluharty, School of Marine Affairs, University of Washington

Environmental Perspective.

David R. Cline, World Wildlife Fund, Bering Sea Program

Canadian Fisheries Perspective.

Richard Beamish, Fisheries and Oceans Canada

Alaskan Inuit Whaling Perspective.

Marie Adams Carroll, Arctic Native Association

The following is a synopsis of the above presentations and does not necessarily represent the views of individual panelists.





6. Perspectives on Ecosystem-based Management



NMFS scientists on research cruise in Alaskan waters.

Photo courtesy NMFS Auke Bay Laboratory Library.

s scientists and managers decipher the complex variety of factors influencing the aquatic environment, an ecosystem-based management approach has the potential for bringing us closer to realizing more sustainable fisheries and marine ecosystems and economically robust coastal communities.

Managing any one resource affects the other resources in that ecosystem. Therefore, resource managers must consider how management actions affect all resources, not just individual species in isolation. An ecosystem is comprised of all the interconnected elements of a geographic area, including all the living organisms, people, plants, animals, microorganisms and their physical surroundings.

The ecosystem-based approach works *with* nature to produce healthy functioning ecosystems or habitats. As humans continue to put pressure on natural resources, an ecosystem-based approach, balanced with current management techniques, can prevent the deterioration of ecosystem elements and maintain the long term health of fisheries and other marine populations.

Policy and Management Perspective

Resource managers are frequently called upon to quickly assimilate information and make decisions within a short timeframe. Therefore, it is important to provide them with the best possible information that is not only species-specific, but also contextually relevant and inclusive. Information derived from a broader ecosystem approach could likely aid the decision-makers in making appropriate decisions.

Maintaining ecosystem health and sustainability is a management goal that most people can understand, whether they are scientific, social or economic stakeholders. The players in Alaska's fisheries management are starting to work together to move management forward. A period of transition is necessary because we don't have a complete understanding of ecosystems and the management institution in place is not configured around ecosystems.

It is important to distinguish ecosystem-based fishery management versus broader ecosystem management. The first task is to identify <u>ecosystem principles:</u>

- Our ability to predict ecosystem behavior is limited.
- Ecosystems have thresholds and limits affecting ecosystem structure.
- If limits are exceeded, changes can be irreversible.
- Diversity is important in ecosystem functioning.
- Multiple time scales interact in and among ecosystems.
- Components of ecosystems are linked.

- Ecosystem boundaries are open.
- Ecosystems change with time.

The primary law that allows us to manage fisheries in the federal zone is the Magnuson-Stevens Fisheries Management Conservation Act signed into law in 1976 and amended as the Sustainable Fisheries Act in 1996. The Magnuson-Stevens Act established the 200-mile federal limit and set in place the regional fishery management councils. The Sustainable Fisheries Act (SFA) called for a reduction in bycatch and an identification of harvest levels, added fish habitat requirements, and established an advisory panel to analyze how ecosystem principles apply to fishery management in the U.S. The panel was tasked with reporting back to science, management, industry, and environmental groups in 1999.

A prerequisite for ecosystem-based fishery management was to fully implement the SFA. The Ecosystem Advisory Panel's recommendations on how to better manage fisheries around the country are incorporated into legislation currently pending before Congress in 2002 that would reauthorize the Magnuson-Stevens Act. In anticipation of this legislation passing, a National Marine Fisheries Service group is working on a further elaboration of some of these recommendations. In addition, the PEW Oceans Commission and the President's Commission on Ocean Policy are also considering similar recommendations.

Currently, Alaska is one of the few places in the world where there is a conscious effort to understand what is happening with the ecosystem as a context for managing fisheries.

Scientific Perspective

The rules that have allowed us to predict fisheries impacts may no longer apply, and the ways fisheries are operating may be changing. Climate-driven changes in the marine environment and changes in fish stocks are influencing managers' thinking.

Climate-induced changes in food (phytoplankton) availability, possibly switching an ecosystem from a "bottom-up" to a "top-down" feeding scenario, may dynamically affect fish stocks and alter whole ecosystems.

Within fisheries, there is a tremendous range of data available to further understand what is happening with the stocks, but information about how fisheries fit into marine ecosystems is scarce. Obtaining data without knowing why it is being gathered and how it will be used is less than useful.

Under the maximum sustained yield management concept and only using stock assessment data, disturbing levels of bycatch can occur. Bycatch of this extent can damage benthic communities and risk depleting marine wildlife, further emphasizing the need for targeted data gathering. Destruction of ancient deep sea corals by Bering Sea trawling operations is a vivid example of how fisheries can affect other populations: fishing in this area in this manner is changing the benthic habitat, which may be important for the

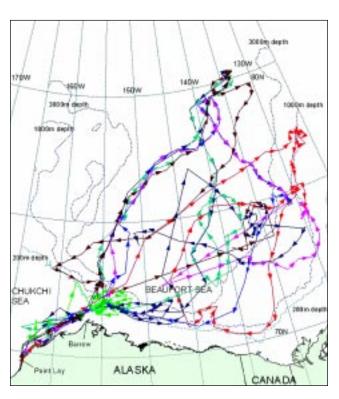


figure 6.1 **Movements of Beluga Whales**

Colored points show movements of beluga whales satellite tagged at Point Lay, Alaska, 30 June - 7 October 1998 and 30 June -25 September 1999. From NMFS "Summary of Beluga Tagging Results, 1998-2000".

Credit: Adams-Carroll. 2002. Oceans and Watersheds Symposium. Anchorage, AK.



Harbor seal research. EVOS photo library.

Intensive bottom trawling zones are being pushed into the home range of the fur seals as a result of the Steller sea lion protective measures— a clear example of how single species management does not work.

recruitment of a commercial species. In this case, it would be important to survey changes in the benthic habitat.

Discarded bycatch also can seriously impact other animal populations. The discards bring energy to surface waters, making it available to gulls, which can cause havoc in mixed species colonies of seabirds. When the bycatch is controlled and no longer available, the gulls that have been on the fisheries dole will shift to foraging on other seabirds, again indicating the need for targeted data gathering.

In order to understand fisheries management, it is important to obtain the right targeted data, and correctly analyze and make sense of it by reviewing the impacts in context.

Environmental Perspective

From an environmental point of view, the goal of ecosystem-based management is simply to maintain healthy oceans, which can be measured by the health of the key predators at the top of the marine food chain—species like Steller sea lions, northern fur seals and killer whales. If fish populations are healthy and in good shape, chances are that predator populations will be also, exhibiting a healthy ecosystem balance.

Pressure on resource management exerts itself from multiple directions—business, fishing industry, citizen conservationists and conservation-minded scientists, tribal governments and fishermen—resulting in some real risks to the marine environment.

Frequently, the response is to take an issue to court, which is not only polarizing, but also puts judges in the position of making resource management decisions. Neutral ground is needed so that responsible parties can do what's best for Alaska's oceans and watersheds.

Averting Disaster

A potentially serious issue in the making is in the central Bering Sea around the Pribilof Islands. Native observers and biologists indicate that the northern fur seal population is in decline. The World Wildlife Fund is working with St. Paul and St. George Islands to avoid repeating population problems that occurred with Steller sea lions.

A sample of over 121 females with attached radio telemetry devices demonstrated that lactating female fur seals sometimes must travel 100 miles or more and dive to several hundred feet at night to get enough food to feed their pups.

Intensive bottom trawling zones are being pushed into the home range of the fur seals as a result of the Steller sea lion protective measures—a clear example of how single species management does not work. If scientists, management agencies and Native Alaskans work together to consider ecosystem impacts, perhaps another Steller sea lion dilemma can be averted. The National Marine Fisheries Service will be conducting a comprehensive population survey and redrafting conservation plans for the northern fur seal. Researchers support development of a Bering Sea International Marine Ecosystem Research Station on the Pribilof Islands.

The goals of ecosystem management are achievable if we keep them in sight and stay out of the courtrooms. If the research community can produce simple measures of

ecosystem biodiversity and productivity, resource managers may look toward an ecosystembased management approach.

Native Perspective

Resource co-management agreements can prove workable as evidenced by the success of the bowhead whale agreements between Alaska Native whalers and government agencies.

Initially, bowhead management conflicts between North Slope Natives, the federal government and the International Whaling Commission were intense, leading to a federal grand jury investigation in 1980. North Slope Natives were told that they needed to cease whaling—a definite lifestyle intrusion. To add further pressure to the resource, a major Beaufort Sea oil and gas lease sale was planned in the bowhead's habitat.

The North Slope Native group signed a co-management agreement with the National Oceanographic and Atmospheric Administration to resolve their differences. In 1981 the group also signed an agreement with the North Slope Borough and the Alaska Eskimo Whaling Commission regarding offshore development, scientific research, and problems with noise impact, specifically helicopter and seismic activity, during bowhead migration.

The ban on hunting bowheads in the 1970s was based on scientific estimates of 600-800 whales. Whaling captains, however, estimated the population to be closer to 3,000 whales, but agreed to work through the Alaska Eskimo Whaling Commission. The captains insisted that the researchers were not counting the whales that travel through and under the ice. Bowheads are able to break through two-foot thick ice (*figure 6.2*). The whalers and scientists together developed an acoustics program that eventually resulted in a more accurate population number of about 3,000 bowheads as the Natives had first estimated. The latest population estimate reported at the International Whaling Commission in 1993 is approximately 8,000 (http://www.iwcoffice.org/estimate.htm).

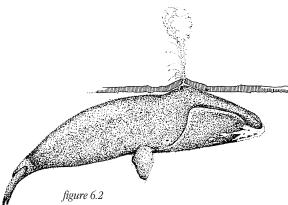
The co-management agreement increased hunting efficiency and more acceptance of traditional knowledge and serves as a powerful example of how things can work in isolated communities.

From a Native perspective, there are three important areas to consider in managing our resources: the resource, the habitat and the user group.

Good Neighbors

Canada is in the process of establishing marine protected areas near the Queen Charlotte Islands—for this country the beginnings of managing according to ecosystem-based principles. Resource scientists and managers hold that conservation based on an ecosystem approach is of fundamental importance to maintaining biological diversity and productivity in the marine environment. The Canadians are implementing an ecosystem-based approach that treats all species equally with their Species at Risk program.

A precautionary management approach makes sense to a whole new generation of biologists in fisheries around the world. Many believe that an ecosystem bill of rights is long overdue.



Artist's rendition of a bowhead whale breaking through the ice to breathe. Credit: Adams-Carroll. 2002. Oceans and Watersheds Symposium. Anchorage, AK.



Photo courtesy Alaska Division of Tourism.





7. Ocean and Watershed Policies and Governance

Panel Moderator:

Rob Bosworth, former Deputy Commissioner, Alaska Department of Fish and Game

Where the Law Meets the Ocean: Proposed Changes to the Magnuson-Stevens Act.

Jim Balsiger,

Alaska Region, National Marine Fisheries Service, National Oceanic and Atmospheric Administration

Co-management: A Way to Involve Local and Regional Interests in Conservation and Management Issues.

Charlie Johnson, Alaska Nanuuq Commission

Alaska Oceans and Watersheds: What Needs to Change?

Jim Ayers, North Pacific Office, Oceana

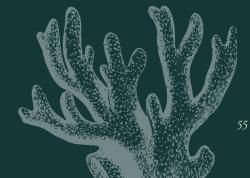
Sound Management in North Pacific Fisheries.

Trevor McCabe, At-Sea Processors Association

Government Perspective.

Pat Galvin, State of Alaska

The following is a synopsis of the above presentations and does not necessarily represent the views of individual panelists.





7. Ocean and Watershed Policies and Governance

he Magnuson-Stevens Fisheries Management Conservation Act of 1976 was a giant step toward conserving ocean wildlife, particularly declining species. It represents a balancing act between the interests of the fishing community to make a reasonable living and the need to maintain a healthy and diverse marine environment.

When the act was amended by the Sustainable Fisheries Act of 1996, it was further strengthened by including issues of bycatch, overcapacity, data collection, ecosystem-based fisheries management, observer coverage, habitat, and IFQs (Individual Fishing Quotas), plus establishment of an advisory panel to analyze how ecosystem principles apply to fishery management.

The basic structure of the Magnuson-Stevens Act has withstood the test of time and served as a strong management foundation. However, because ocean processes are dynamic, the act is continually subject to change. Changes currently (summer and fall of 2002) under consideration include:

Bycatch: Change to include individual boat restrictions so that every skipper has some responsibility rather than having a global or fleetwide responsibility. Create individual boat incentives.

Capacity: National Marine Fisheries Service is asking for better capability to reduce fleet sizes, either through buyback programs or other types of capacity reduction, possibly including individual fishing quotas and vessel bycatch allowances. The general direction is to bring the responsibility to the individual fisherman.

Fisheries observers: Despite the difficulty of finding funding, the goal is to have observers in all fisheries. Although it is an expensive program, it is a good way of collecting data and managing fisheries. As of 2002, there are 36,500 observer days on fishing boats off Alaska.

Law enforcement: Develop the ability to use high tech information such as vessel monitoring systems (VMS) and satellite transponders so fishing vessel locations can be pinpointed. Steller sea lion recovery requirements have made it mandatory for cod, pollock and Atka mackerel fishing boats to be VMS-equipped.

Ecosystem management principles: The time is right to meld them into the Magnuson-Stevens Act.

Communities: Closer work with stakeholders in coastal communities is needed to avoid post-decision, post-regulation confusion.



Trawler in the Bering Sea.

Photo courtesy NMFS Observer Program. NOAA.

The National Marine Fisheries Service and other agencies are looking forward to these changes as one more step toward sensible coordinated ocean governance and regulation. The status of the pending legislation can be checked on the Library of Congress website (http://www.thomas.loc.gov).

Progress in Co-management

Co-management is essentially a function of the political process. In Alaska, the process has historically been primarily between Alaska Native groups and tribes and the Federal government. Although there are a few agreements around birds, most co-management agreements center around subsistence hunting of marine mammals because the Federal government has management authority over these animals.

New agreements are modeled after that of the Alaska Eskimo Whaling Commission because of its success. The bowhead whale co-management agreement was negotiated in good faith, and both parties respected each other. Whalers were willing to share their knowledge, while the management agency was willing to consider and accept traditional knowledge and share management responsibility.

The process brought good science to the forefront and made it available. In the 1970s the National Oceanic and Atmospheric Administration estimated the bowhead population at 600-700 whales, while the Native whaling captains estimated the population to be about 37,000 whales. The current bowhead count is approximately 10,000. More accurate counting is a result of working together as co-managers.

The Alaska Nanuuq Commission participated with the U.S. Fish and Wildlife Service in the negotiation of a bilateral treaty with Russia, signed in October 2000, on the shared Alaska-Russia polar bear population. Both governments accepted the Native people as equal participants in the negotiations. The Russian Ambassador described it as the most democratic treaty Russia had ever signed. The commission operates on a unanimous consent basis among Native and government representatives from both countries—true comanagement. Similar to the Alaska Eskimo Whaling Commission, the commission will be setting quotas. As a result of the treaty, the United States will gain data from Chukotka about the denning habitat, feeding areas and movements of polar bears located here.

Co-management makes traditional knowledge and local knowledge available to the management agencies, allows user groups to participate in setting research priorities, promotes sustainability, and spreads out the economic benefits among a broader group of people.



Photo courtesy Alaska Division of Community & Business Development, Robert Angell.

Co-management makes
traditional knowledge and
local knowledge available to
the management agencies,
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out the economic benefits
among a broader group of
people.

Approaches to Resource Management

Several approaches to resource management are frequently pressed into usage: crisis management, political power-based and research-based.

Crisis management approach

When influence and management are focused on single species harvest, value and location, the structure fails to consider the health of the ecosystem. A strong example of crisis management is the Steller sea lion scenario in which decisions were made without sufficiently considering their effects in a broader context. Clearly the decline in Steller sea lions is a serious problem that will not be resolved in court; it needs collaborative attention. The problem has, however, stimulated discussion on ecosystems and the cumulative impacts of decisions regarding ecosystems.

Political power-based approach

When people in Congress or a state legislature decide that something is a bad idea, they can block forward progress. If we want healthy oceans, it's advisable for Alaskans to discuss, converse and resolve problems before individuals with political power start adding riders to bills to satisfy their interests.

Research-based approach

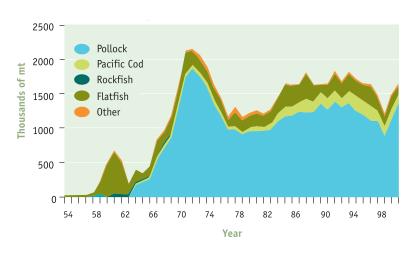
The research-based approach requires the cooperation of scientists and those holding traditional knowledge, meeting locally and regionally, to make decisions about what is good and right for the health of our oceans, instead of letting commercial or interest groups make decisions.

An example of unhealthy ecosystem decisions is the destructive practices decimating Alaska's coral and sponges. These 500-1000 year-old animals are torn up regularly as fisheries bycatch. Most scientists are in agreement that this situation should be rectified, but the situation is allowed to continue. With cooperation between research centers and research institutions, we could have an ecosystem management system that includes an ecosystem council and a national agency dedicated to the protection of our oceans. Alaska can lead the way; no one in the country is having this kind of a conversation on a regional basis.

figure 7.1

Bering Sea Groundfish Catch 1954-2001

Trevor McCabe. 2002. Oceans and Watersheds Symposium. Anchorage, AK.



Current Management

Alaska has a great management system in place and one of the most progressive fishing industries in the world that cares about long term resource sustainability.

The system is far from stagnant. It's a dynamic process that continues to change—the laws change, Magnuson-Stevens amendments change, and regulations change. Lawsuits are also a significant catalyst for change.

The ecosystem principles taken from the National Research Council and National Academy of Sciences have guided our management efforts:

- Strong science and research
- Precautionary and conservative catch limits (figure 7.1)
- Effective reporting and in-season management
- Comprehensive observer program
- Bycatch and discard limits
- Habitat protection (figure 7.2)
- Limited entry programs
- Ecosystem considerations

North Pacific Fisheries Management Council

All of these concepts have been implemented in the North Pacific, but are lacking in many other parts of the country. The North

Pacific Fisheries Management Council has also successfully expanded on the checklist with solid abundance surveys, conservative catch limits, no over-fished groundfish species, good in-season reporting, a comprehensive observer system, and an expansive system of marine protected areas.

All the information from these expanded elements is used to open and close fisheries, close designated areas, enforce bycatch limits, and monitor harvests and the taking of mammals under the Marine Mammal Protection Act.

Although this same information has reduced arguments with conservation groups, there are still frequent legal actions. If the groups came up with a comprehensive prioritized plan, the ecosystem would be better served. It is important from a management and economic perspective however, that a healthy ecosystem does not translate to an ecosystem with no fishing.

Where We're Headed

As always, we need more science, but we are well-positioned to get it and use it, responding as the science comes in and tells us what to do to protect the ecosystem. We have the support of Alaska's Congressional delegation, targeted Steller sea lion funding, the North Pacific Research Board, the *Exxon Valdez* Oil Spill Trustee Council's GEM Program, the fishing industry, and others.

Second, it's important to complete the rationalization effort. Rationalization means developing an integrated management approach to fisheries that is rational from the perspective of resource conservation and the economics of the harvesting industry. Rationalizing the fisheries will never happen quietly, but the participants in all of the North Pacific fisheries are largely ready. The Magnuson-Stevens model has many strengths, but one frequent criticism is that almost every decision the North Pacific Fisheries Management Council makes has an allocative flavor, with decisions benefiting one group and possibly negatively affecting another. With rationalization systems, you find a cleaner discussion of conservation measures, with a focus on ways to harvest fish with the least environmental impacts.

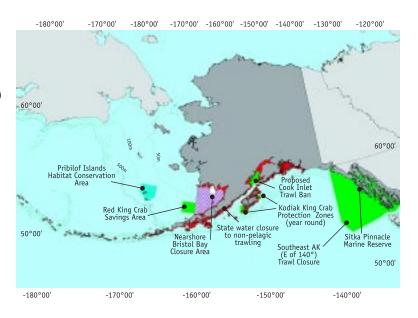


figure 7.2 Habitat Protection

Council.

Marine protected areas have been established to protect sensitive habitats from potential effects of fishing. Yearround bottom trawl closure areas (>90,000 nm²) are shown on this map. Credit: North Pacific Fisheries Management



Governance Models

Ocean governance is very much at the forefront at this time in history, akin to 30 years ago when the Stratton Commission was brought together to look at similar issues. That commission's findings resulted in the formation of the National Oceanic and Atmospheric Administration and the creation of the Coastal Zone Management Act, structures we have been working with for 30 years.

Some of the current larger themes of ocean governance include a need for some sort of national policy, a need for coordination among Federal, state, and local authorities, incentive-based participation, and a regional effort to facilitate a more ecosystems-based approach.

There are a number of models of how governance structures could be put together, but an effective model to examine is the Coastal Zone Management Act. When it was first created by Congress in 1972, it established a number of things present in discussions today regarding the governance structure: emphasizing state or local goals and objectives, and allowing for enforceable policies to be brought together at a local, rather than a national centralized, level.

With the incentive of money and Federal consistency, states could, but were not required, to participate in the Coastal Zone Management program. Participating states developed local plans and did what they could in the area of coastal management, identified at the time as one of the nation's biggest concerns. Eventually, a few weaknesses showed up in the Coastal Zone Management system: no national standards, and a recognized failure to be able to handle issues of national needs, such as non-point source pollution.

Anyone looking at governance structures should examine what other states have tried to do in with their Coastal Zone Management program to bring local, state and Federal authorities together to create collaborative opportunities.

